OFFICIAL PUBLICATION

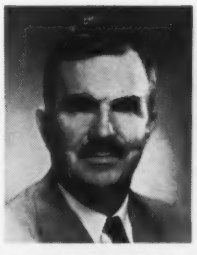
JOURNAL

Heating • Refrigerating • Air Conditioning • Ventilating

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS

A NEW PSYCHROMETRIC CHART IN THE MAKING?

[It was the topic of a Symposium at Dallas]



A good psychrometric chart should be more than an expression of the thermodynamic interrelationships of air and water vapor.

C. M. ASHLEY

My purpose is to introduce a new form of psychrometric chart applicable to many different barometric pressures.

J. L. THRELKELD

See page 73

J. A. GOFF

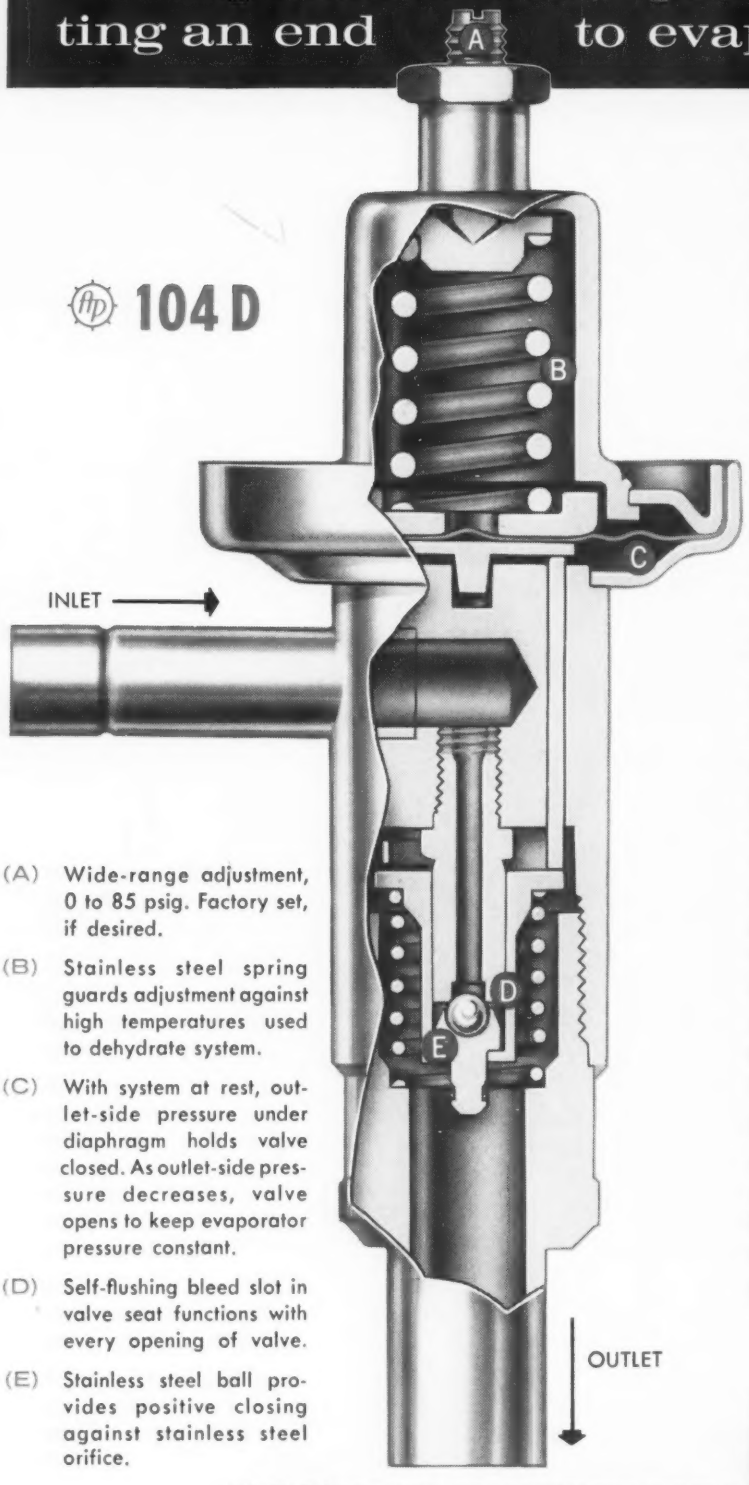
A chart that, however accurate it may be, either lacks thermodynamic consistency or, having it, conceals it out of deference to tradition, is not likely to make a lasting contribution to the welfare of the profession that the Society represents.

D. D. WILE

So far, no single chart has met the perfection desired . . . with the ease of use and practical accuracy that is sought. The present Society chart due to its size and complexity is rarely used by engineers in their day-to-day work.

APRIL 1960

In room air conditioners and water coolers that wear the brand names of Carrier, Emerson, Fedders, Halsey Taylor, Whirlpool, York . . . this new constant pressure valve protects their performance by putting an end to evaporator freeze-ups



104 D

(A) Wide-range adjustment, 0 to 85 psig. Factory set, if desired.

(B) Stainless steel spring guards adjustment against high temperatures used to dehydrate system.

(C) With system at rest, outlet-side pressure under diaphragm holds valve closed. As outlet-side pressure decreases, valve opens to keep evaporator pressure constant.

(D) Self-flushing bleed slot in valve seat functions with every opening of valve.

(E) Stainless steel ball provides positive closing against stainless steel orifice.

AND IT'S HERMETICALLY SEALED FOR FAST, EASY INSTALLATION

Here's a proven design for volume production — ready to go, nothing to assemble. And that's just the start of it, for this constant pressure valve eliminates evaporator freeze-ups regardless of load.

Triggers instant cooling action. The 104D stays closed during the off cycle . . . opens as required to keep evaporator pressure constant. With the valve bleeding off the high side pressure during off periods (within the two-minute UL specification), there's no chance for starting overloads, even with low-torque motors.

Ideal for other uses. The performance-protecting values offered by this new valve are not confined to room air conditioners and water coolers. With cost tuned to the needs of volume production, the 104D is ideally suited for use in cold beverage and food dispensers, ice cream cabinets, bottle and milk coolers, dehumidifiers. Whatever the installation, you can be sure of dependability that virtually eliminates service problems.

Controls Company of America is uniquely equipped to help you solve your control problems. A note from you will bring complete details about the AP valve (104D) featured here. Or ask for facts about other control opportunities.

Creative controls for industry

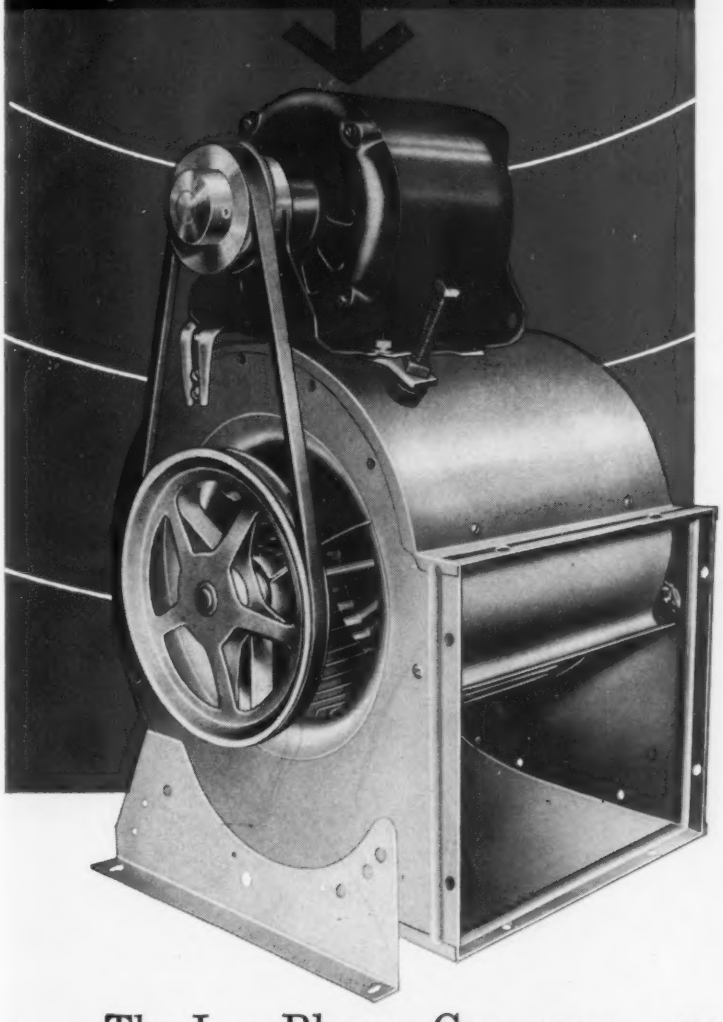
CONTROLS COMPANY OF AMERICA

HEATING AND AIR CONDITIONING DIVISION

2456 N. 32nd Street, Milwaukee 10, Wis. • COOKSVILLE, Ontario • ZUG, Switzerland

HAC-14-60

SERIES A



"Features exclusive LAU FIRSTS"

Here's the most versatile blower manufactured today! The Lau Series A is extremely efficient in many applications because of its availability in such a complete performance range. Assorted wheel sizes, four standard discharge positions, and a wide selection of C.F.M. characteristics mean you can specify a blower that's practically custom made for you . . . at no extra cost.

Standard Series A features include such Lau exclusives as Preslok® wheels, ground and burnished shafting, Lau Pak Gold Seal bearings, tripod bearing brackets, heavy gauge housing supports, versatile motor mounts, and Lausteel pulleys.

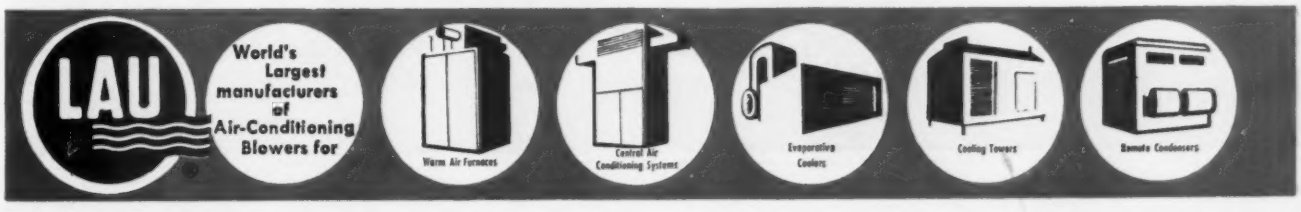
Series A blower assemblies are recommended for warm air furnaces, central air conditioning systems, evaporative coolers, cooling towers, and remote condensers.

Write or call Lau today. We will place you in contact with your experienced Lau Sales Engineer. He's always nearby and ready to help you solve any air moving problem.

MEMBER INDOOR COMFORT

The Lau Blower Company, 2027 Home Avenue, Dayton 7, Ohio.

Other plants in Kitchener, Ont., Can., and Irwindale, Calif.



APRIL
1960

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FEATURE

NEWS

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Comment

STATISTICALLY VULNERABLE?

Like the chap in the story who, having fallen from the top of the Empire State Building, passed the mid-point of his descent with the optimistic observation that he was all right so far, our economy may remain in bright contemplation until close to impact with reality.

Who pays attention to dull, factual signposts when the going is good?

For the record, here is something to think about. Since World War II net private debt in this country has risen from $200 billion to $500 billion. Or, from being a bit less than the nation's net personal income after taxes 14 years ago to nearly 50% larger than is today's disposable income.

Again, for the record (we refer to the Wall Street Journal of March 7) "The nation's commercial banks, which have plunged deeply into new consumer credit plans in the past year or so, now are having serious second thoughts. Some of them are pulling out; others are playing down the new plans."

Civilization has ever experienced changes of a salutary nature. Can it be that we are about to return to the Payasyougoic Age?

CHARTING THE WAY

One of the more spirited of recent National Meetings Symposiums was a notable feature of the Dallas program—the Psychrometric Chart session, where most distinguished members (including two Society presidents and two university professors) sought variously to redefine the kind of psychrometric chart that would be most useful, practical, adequately accurate and authoritative.

True, that Symposium did not resolve the matter, nor did the later session to which the former was adjourned, but it is clear that before long there will be a new, smaller, simplified and Society-sponsored sheet which will be a strong factor in the improved specification of related equipment for the coordinated consideration of temperature and humidity factors and their means of control.

More than half a century old, the Psychrometric Chart is in imminent danger of being reborn.

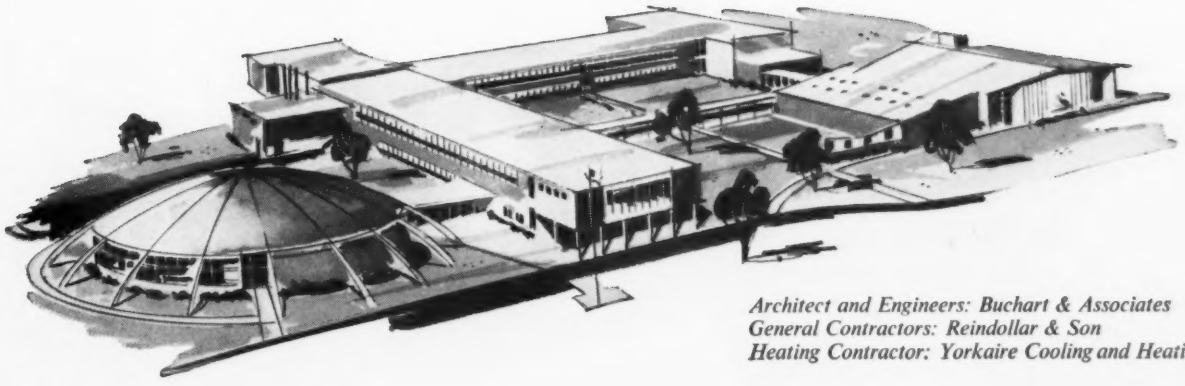
Edward R Searles
Editor

Mr. Curtis A. Botts—heating and ventilating contractor for the new Hannah Penn Junior High School, York, Pa., says:

"Working with Honeywell, and finished

Mr. Curtis A. Botts, President of the Yorkaire Cooling and Heating Company, in one of the Honeywell-controlled classrooms at Hannah Penn Junior High School. For excellency of design, this beautiful new school was awarded a certificate of merit by the American Society of Registered Architects.

we started the job on time."



Architect and Engineers: Buchart & Associates
General Contractors: Reindollar & Son
Heating Contractor: Yorkaire Cooling and Heating Co.

Trained Honeywell specialists helped keep Hannah Penn school on schedule, supervising the temperature control system during planning, installation and checkout.

"Honeywell's trained specialists helped us avoid costly delays," says Mr. Botts. "They turned in clear shop drawings of the temperature control system. They helped speed up equipment deliveries. They gave us good supervision during installation, then checked out the entire system. As a result, we started on time, and *stayed* on time until the job was finished."

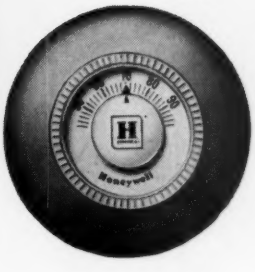
The result for this handsome new school is an efficient, smooth-working temperature control system with wall-mounted classroom thermostats—a system that assures an indoor climate ideal for better teaching, better learning.

If your next job calls for a temperature control system by Honeywell, you'll get all the help you need from skilled, efficient specialists—help that saves you money, time and worry. Get the whole story; call one of the 112 Honeywell sales and service offices nearest you. Or write Honeywell, Dept. AH-4-75, Minneapolis 8, Minn.

Honeywell

First in Control

SINCE 1885



The Honeywell Round Thermostat—famous symbol of quality temperature control

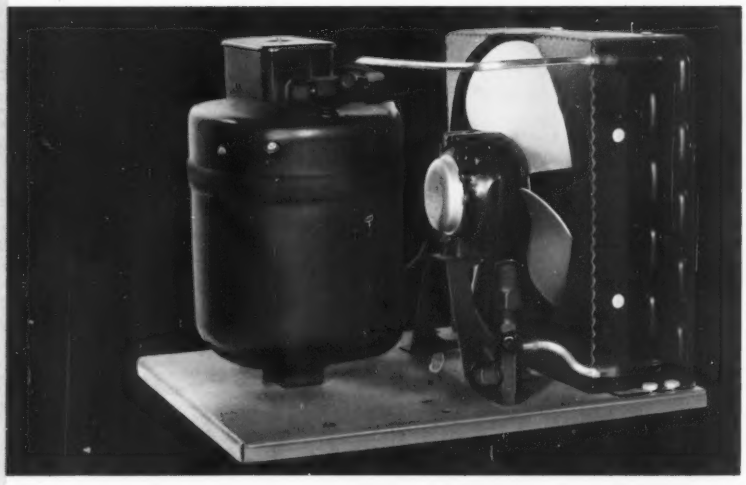
75th YEAR — PIONEERING THE FUTURE


TORRINGTON HAS ANALYZED THE INPUT TO OUTPUT EFFICIENCY CORRELATION IN THOUSANDS OF DIVERSIFIED APPLICATIONS OF AIR MOVING COMPONENTS
FOR COOL HORSEPOWER IN ALL KINDS OF AIR MOVING REQUIREMENTS:
FROM THE HEAVY-TONNAGE SPECIFICATIONS FOR HEATING, VENTILATING AND AIR CONDITIONING PRODUCTS TO THE ULTRA-PRECISE COOLING REQUIREMENTS OF SPACE-AGE ELECTRONICS EQUIPMENT.
THAT'S WHY ENGINEERS TOSS THEIR AIR MOVING PROBLEMS TO TORRINGTON!
THE TORRINGTON MANUFACTURING COMPANY
TORRINGTON, CONNECTICUT • VAN NUYS, CALIFORNIA • OAKVILLE, ONTARIO

"5th DEGREE" TESTING AVOIDS REJECT "RAPS." You can't pin a reject-causing rap on this compressor. Like all Bendix-Westinghouse compressors and condensing units, it was completely checked out at the factory. Five separate operating tests were made—suction pressure, head pressure, low-voltage operation, over-all performance and efficiency. Sure, it takes extra time to make these checks, but it pays off by eliminating line rejects for our customers—by as much as 75%. Why not look at the details of a new Bendix-Westinghouse condensing unit of compact design appearing on the back of this page and see how it makes possible less first cost, less operation cost and more refrigeration space.

Bendix-Westinghouse MOTOR COMPRESSORS

NEW BENDIX-WESTINGHOUSE CONDENSING UNIT LETS YOU DELIVER LESS FIRST COST, LESS OPERATING COST, MORE REFRIGERATION SPACE



Manufacturers of beverage coolers, vending machines, water coolers, dehumidifiers, and other general commercial-type cooling equipment will welcome this newest Bendix-Westinghouse development!

The Bendix-Westinghouse Model BYCH25 ¼-h.p. Condensing Unit is ideal for low-cost, high-volume applications. Its compact design permits refrigerated compartment space to be increased to give more cold capacity area in standard-size cabinets.

The secret of this new refrigeration advance?

The new Bendix-Westinghouse "Oval-Line" motor compressor—latest improvement in compressor engineering. The motor is of two-pole design, which means lighter weight, smaller size and lower cost.

The BYCH25 also has new and better motor insulation, inherent overload protection, full suction gas cooling, positive pressure lubrication and glass terminals, all of which contribute to a longer, more dependable operating life.

If you use fractional-horsepower compressors or condensing units in your manufacturing operations, it will pay you to get *all* the facts on the *new* Bendix-Westinghouse BYCH25—latest and best news in condensing units. Call or write direct.

Bendix-Westinghouse

EVANSVILLE, INDIANA

A Division of Bendix-Westinghouse Automotive Air Brake Company, Elyria, Ohio
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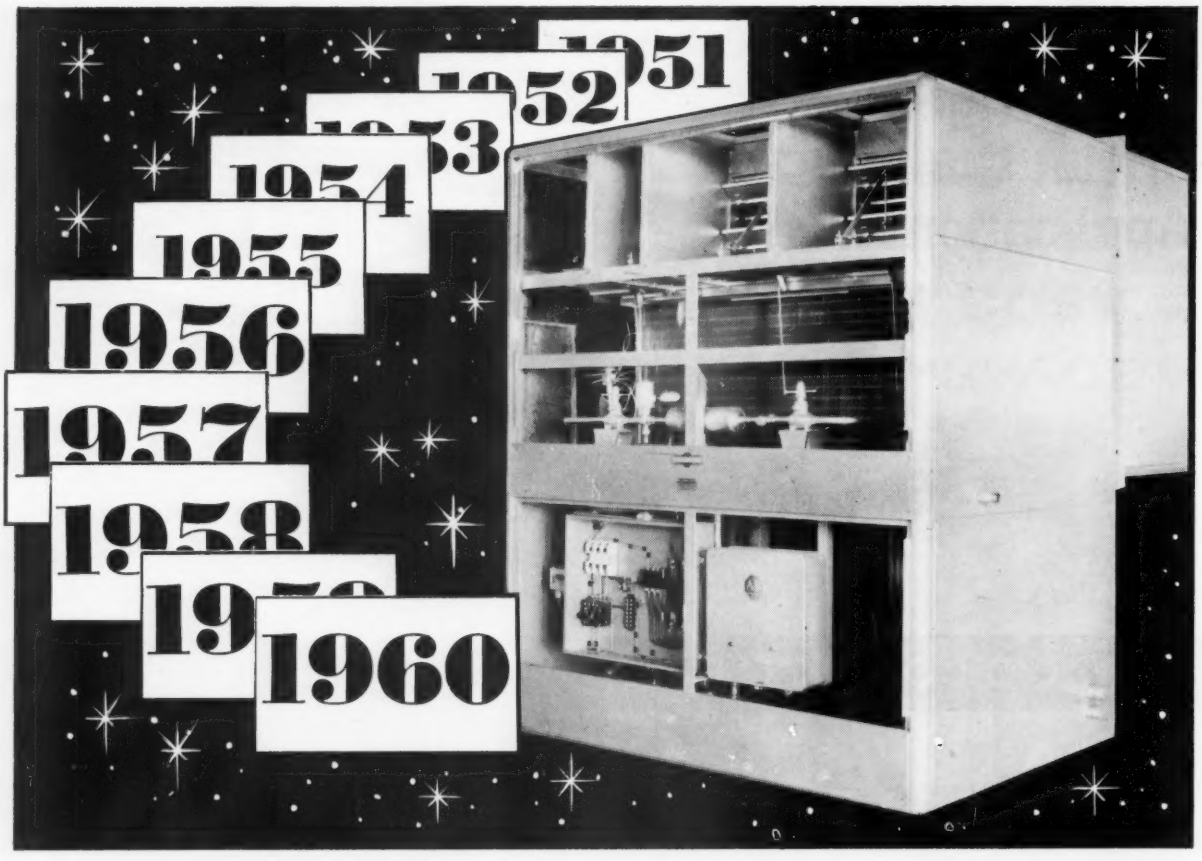

a decade of **proven** performance in self-contained multi-zone units

Yes, for ten years, GOVERNAIR has led the way in the engineering and development of self-contained multi-zone air conditioning units.

Both the Evaporative Condenser Package (type SCMZ) and the Water Cooled Condenser Package (type STMZ) are far beyond the pioneering stage, and have been tested and proven in actual use throughout the world, under widely-varied conditions.

Available in 8 through 100 tons, every unit is "Satisfabricated" to fit individual job zone and capacity requirements . . . assembled from the finest materials and components, then thoroughly factory-tested before delivery. For complete information, please write . .

GOVERNAIR

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Low Water Cut-offs on Hot Water Boilers?

...the industry has given the answer

Yes, the answer has come from the field . . . from the engineers, contractors and manufacturers. They have seen the logic of installing a water level control on hot water space heating boilers . . . a low water cut-off, or—for even greater precaution—a feeder cut-off combination.

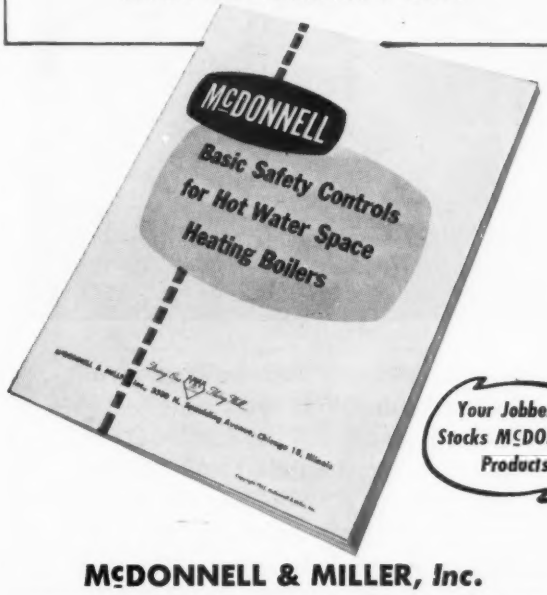
We knew it was a good idea. Expected it to grow and grow. But frankly we have been surprised at how rapidly the heating industry has taken hold of water level control as a logical team mate for an ASME pressure relief valve.

In fact, many local codes now require a low water cut-off, or feeder cut-off combination, on hot water boilers installed in places of public occupancy—including multiple dwelling units.

Notice the diagrams of recommended installations opposite. For more detailed discussion get this booklet that tells the whole story: "Basic Safety Controls for Hot Water Space Heating Boilers."

The What-Why-How in eight interesting pages

Write for Bulletin P-30C



Your Jobber Stocks McDONNELL Products

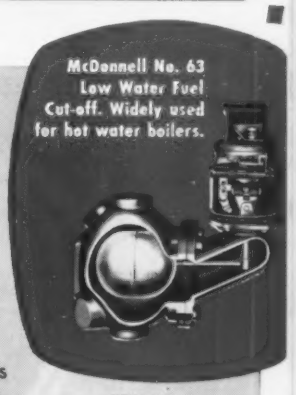
McDONNELL & MILLER, Inc.

3500 N. Spaulding Ave., Chicago 18, Ill.

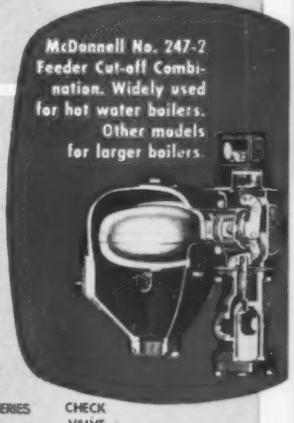
Doing One Thing Well

McDONNELL

Boiler Water Level Controls



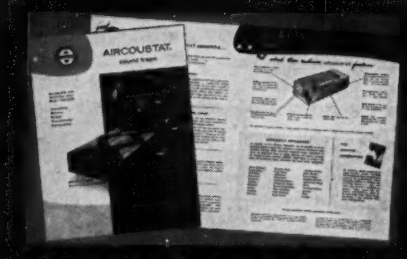
1 The essential low water control for a hot water boiler. A McDonnell Low Water Cut-off located above lowest permissable water level; also McDonnell A.S.M.E. Pressure Relief Valve.



2 The safest and most complete control for a hot water boiler. Offers a combination of mechanical and electrical safeguards which is today's best and most complete answer. A McDonnell combination Boiler Water Feeder and Low Water Cut-off; also McDonnell A.S.M.E. Pressure Relief Valve.

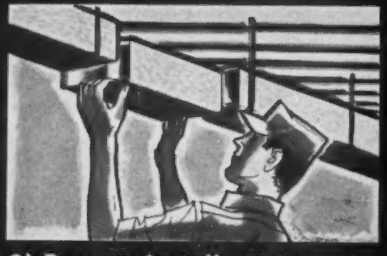
7 ways AIRCOUSTAT®
can save you time and money

Sound Traps . . . with Guaranteed Results

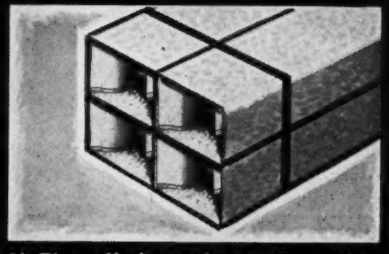


1) Easy to select—Just 3 steps to specify proper model. Save time, avoid errors.

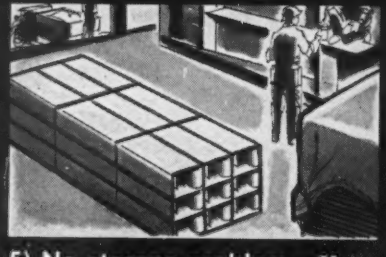
2) Easy to handle—No riggers or special equipment needed. Large units composed at job site.



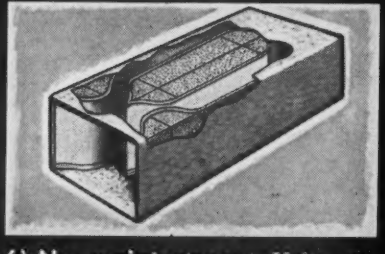
3) Easy to install—Units are installed the same as ductwork. Units have 2" extensions.



4) Fits all duct sizes—Big units are easily assembled from small Aircoustat units.



5) No storage problem—Units are delivered right to the job site, ready to install.



6) No maintenance—Units are fire-resistant, dust-proof and built to last a lifetime.

7) Guaranteed results—Solves every noise reduction problem. Units are completely reliable.

Pre-engineered by Koppers to eliminate guesswork, unnecessary calculations and difficult installations, AIRCOUSTAT Sound Traps guarantee trouble-free silencing of all duct-transmitted noise . . . at a savings in time and money to you.

AIRCOUSTAT selection is quick, simple and reliable. A choice of over 60 stock models, fabricated in 6 lengths, solves every noise reduction problem. AIRCOUSTAT is built to give a lifetime of maintenance-free service.

Write today for your copy of the AIRCOUSTAT Selection Manual, a quick guide to the right unit or combination of AIRCOUSTAT units to eliminate duct-transmitted noise in all air handling systems. Write KOPPERS COMPANY, INC., Sound Control Department, 3503 Scott Street, Baltimore 3, Maryland.

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Engineered **Products Sold with** ***Service***

These units deliver exactly what they promise

"We selected Krack units for the 'Centrella' refrigeration system because they produce at rated capacities. We can design to specifications without fear of underestimating performance."

—A. W. Theis, Theis Refrigeration, Chicago

PURE Centrella FOODS

KRACK SPECIFIED

Central Grocers Cooperative's new, ultra-modern warehouse in Franklin Park, Illinois serves 400 "Centrella Foods" member grocers daily in a 4-state area. Frozen foods, meats, and dairy products are kept in fresh condition in 23,000 sq. ft. of refrigerated space served by 14 KRACK unit coolers.

The accurate capacity ratings of *all* Krack equipment give you these advantages:

1 *No need to specify "oversize" equipment*

When you select Krack equipment, you do not need to include costly "safety margins" in your estimate to compensate for uncertain performance. You can be sure that Krack units will deliver their full rated capacities.

2 *Get the "jump" in competitive bidding*

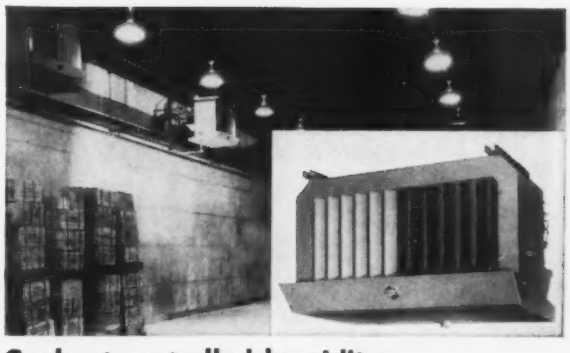
By specifying the right equipment for each job, you trim the "fat" off of both original equipment and installation costs . . . and consistently bid lower on all jobs.

3 *Save yourself installation headaches*

With Krack job-rated equipment you can complete more installations smoothly without hitches. Installations go faster . . . save you time and money.

4 *Eliminate costly callbacks*

Krack equipment will give less maintenance trouble than equipment which is not really rated for the job it has to perform. Specifying Krack equipment is a good way to retain priceless customer good will!



Cools at controlled humidity

6 Krack Ceiling Mounted Unit Coolers chill temperature in cooler room to 40° F. for controlled humidity cooling. Dual purpose drain pan catches drip from expansion valve and directs air flow forward and upward for correct air distribution.

Goodbye to ceiling frost

Krack Electric Defrost Unit Coolers keep temperatures in storage freezer room at 0°F. Heat is circulated *within* unit . . . is *not* released into room to create ceiling frost. For defrosting cycle, door automatically shuts, sealing interior of insulated unit. Automatic defrost is accomplished in a cycle sequence without shutdown of the entire system.

KRACK REFRIGERATION APPLIANCES INC.

Manufacturers of freon, ammonia, flooded ammonia heat transfer equipment

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9520

WHAT 7 THINGS HAPPENED RECENTLY AT FRICK COMPANY* IN WAYNESBORO, PENNA.

?

7 important things for FRICK *. . . and you:*

1. First of all, on a foundation of our 107 years' experience, our new management has established a growth policy that stresses new product development, quality control, and expansion of field services.

2. New branch offices are being opened and the sales-engineering staffs of existing branches as well as of the home office are being increased.

3. A compressor of new design is being developed. This, like our current dependable line, will handle a variety of refrigerants such as Freon, ammonia, propane, butane and carbon dioxide.

4. A new circulating system using refrigerated sea water has been introduced to commercial fishing fleets, at a saving to boat owners.

5. Completely insulated Shell-Ice makers have been "packaged" for convenient field installation.

6. Service to the growing poultry industry has been highlighted by our new counter-flow-continuous poultry chiller, which uses refrigerated water instead of ice.

7. As part of the growth policy, we are increasing the number of Frick distributors. Some of our distributors have been with us 50 years.

All of which indicates one thing: Frick is "on the move!" If you're passing through Waynesboro this summer, stop in and see for yourself; you'll be able to enjoy our remodeled and air conditioned offices.

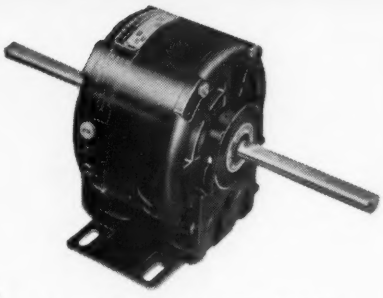
FRICK COMPANY

Waynesboro, Penna.

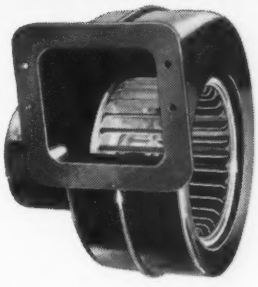
*Pioneers in depend*ability* since 1853: air conditioning, refrigerating, ice making and quick freezing equipment, power farming machinery and portable sawmills.

INCREASE YOUR SALES!

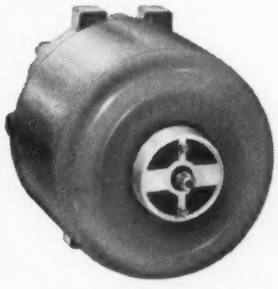
Authorized *Redmond* Distributorships Available in Selected Markets!



air conditioning replacement motor



for applications through 325 cfm



condenser fan motor

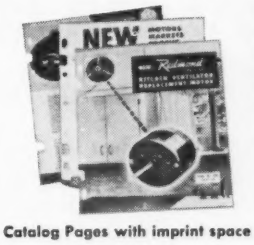
"all in one" replacement kit

Redmond offers you both a complete line of fhp electric motors, blowers, kits, and accessories, and the name that is known nationally as "The BIG Name in Small Motors."

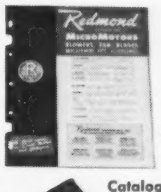
As a Redmond Distributor you profit because of the products available to you, and you increase your sales because Redmond gives you without charge the most complete line of sales and merchandising aids available, backed up with a complete advertising program. It will pay you to take a minute to find out if the Redmond Distributorship in your area is still available. Just fill in the coupon below.

FREE SALESMAKERS

Wall Charts



Catalog Pages with imprint space



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Counter cards

Motor Handbook

Postcards with imprint space

Stuffers with imprint space

Franchise circulation ads

National trade, technical, and consumer advertising

Redmond DISTRIBUTORS DIVISION
Redmond Company, Inc., Owosso, Michigan

I'm interested in obtaining a Redmond Distributorship.

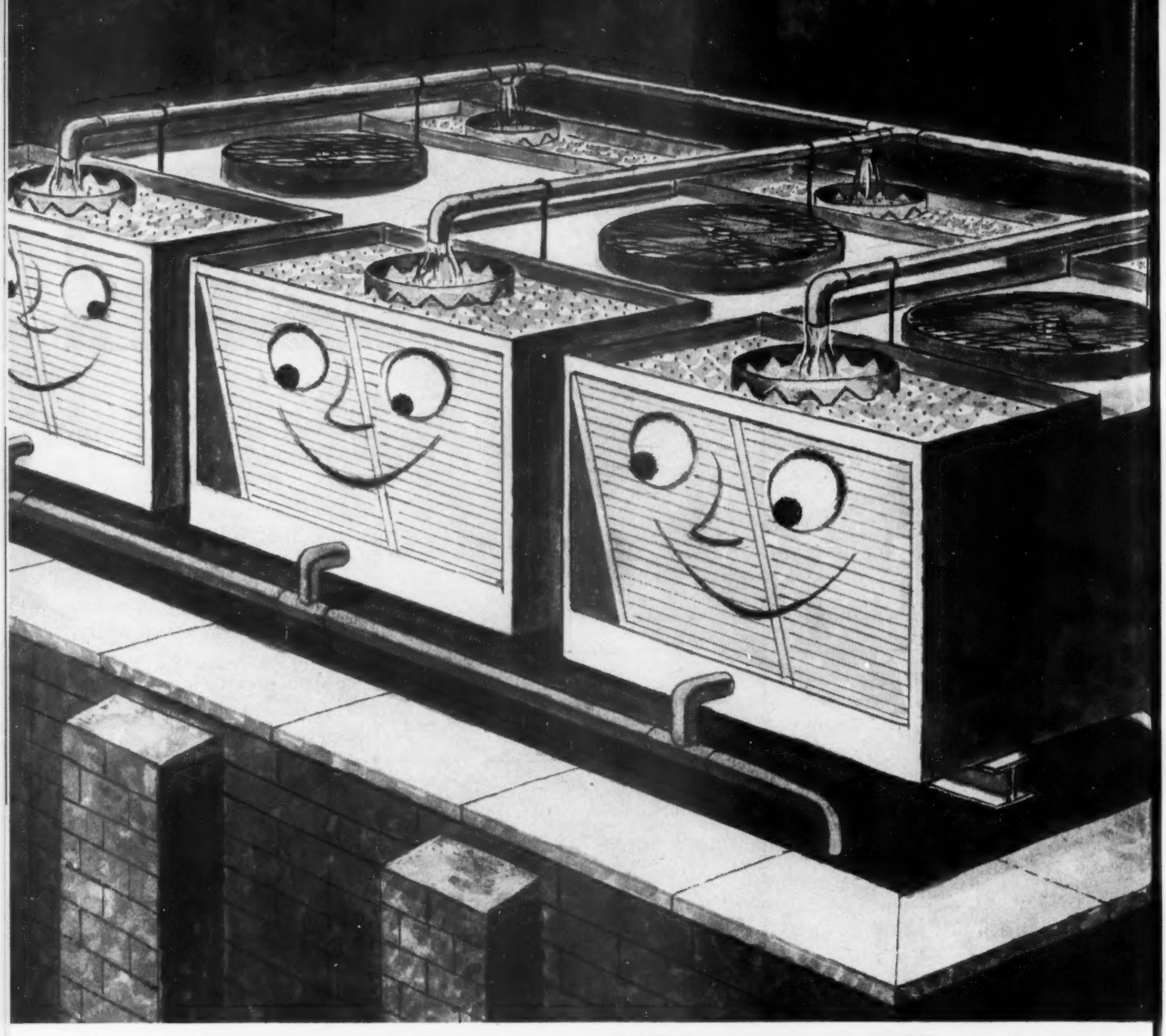
Is one in my area still available?

NAME_____

FIRM_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____



How to cut costs on a 450-ton cooling job:

Use three Halstead & Mitchell 150-ton cooling towers!

H&M MODEL EC-150 COOLING TOWER
WITH 10-GAUGE STEEL CABINET

How can three units be cheaper than one? Simple. Halstead & Mitchell packaged cooling towers come to you completely assembled and therefore less expensive to install. They operate at lower cost because there can be no wasted capacity; with step-control, you get capacity as you need it.

Furthermore, with "modular" units, you can place each tower near the equipment it's to be used with. This gives you closer control of water temperatures—another economy factor. Then, too, if one tower must be shut down, you can continue to operate the others.

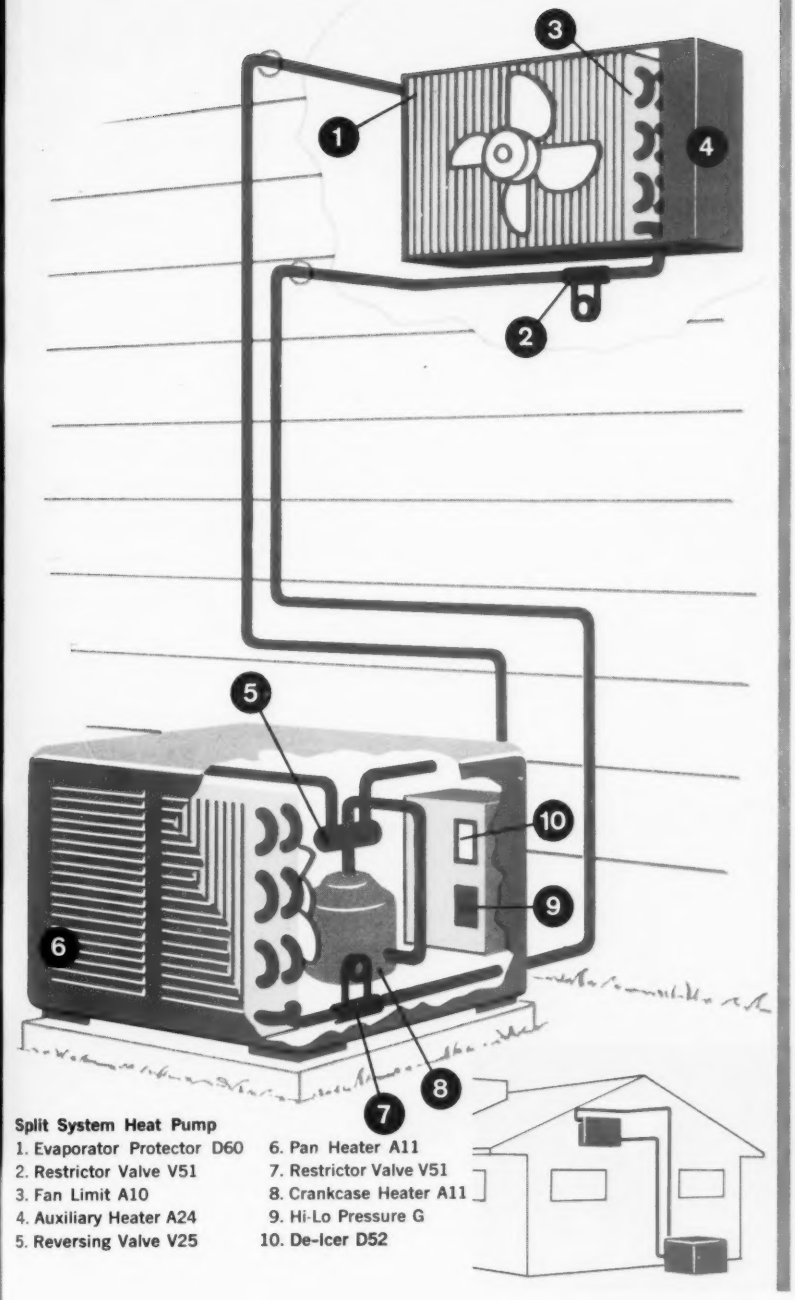
The advantages go on and on: lower silhouette, lower rigging costs, and utmost flexibility—towers can be easily moved or supplemented as requirements change. And, like all H&M towers, these carry the exclusive 20-Year Guarantee on the wetted deck against failure due to fungus attack or rotting.

Contact your Halstead & Mitchell distributor for complete information on H&M cooling towers in 3- to 150-ton capacities. Or write Halstead & Mitchell Co., Bessemer Bldg., Pittsburgh 22, Pa.

HM

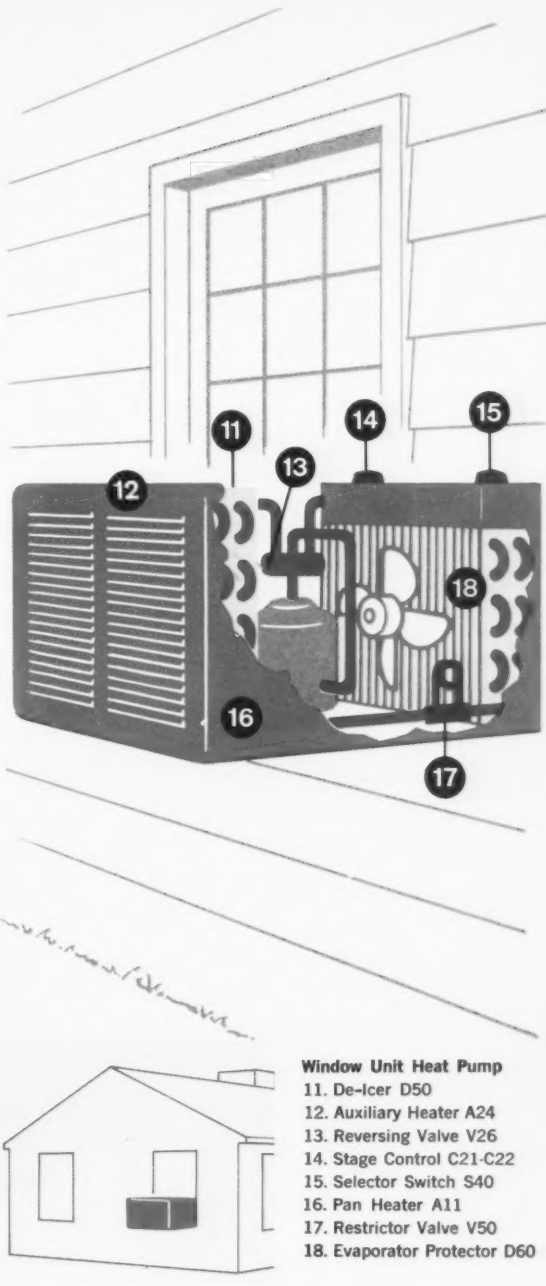
Halstead & Mitchell

Cooling Towers • Water-Cooled Condensers • Air-Cooled Condensers • Finned Coil Products • Air-Handlers



Split System Heat Pump

1. Evaporator Protector D60
2. Restrictor Valve V51
3. Fan Limit A10
4. Auxiliary Heater A24
5. Reversing Valve V25
6. Pan Heater A11
7. Restrictor Valve V51
8. Crankcase Heater A11
9. Hi-Lo Pressure G
10. De-Icer D52



Window Unit Heat Pump

11. De-Icer D50
12. Auxiliary Heater A24
13. Reversing Valve V26
14. Stage Control C21-C22
15. Selector Switch S40
16. Pan Heater A11
17. Restrictor Valve V50
18. Evaporator Protector D60

Automatic Heat Pump Controls by Ranco

Designed for practical applications, Ranco controls are the most complete and advanced line in the industry, help you take full advantage of the growing market for heat pumps. These new heat pump controls and valves, pioneered by Ranco make heat pump operation automatic and simple for both window-type units and central heating-cooling systems.

The wide line of Ranco controls for heat pumps includes de-icing controls, slide-type reversing valves, and automatic cycling controls. Their practical design permits broad adaptation, plus operation in a wide geographical area. Thorough testing under all types of conditions in laboratory and field assures top performance and dependability.

More than 100,000,000
Ranco Controls now in use

RANCO CONTROLS

Ranco®
INCORPORATED
COLUMBUS 1, OHIO

For additional information on the practical application of heat pump controls, contact Ranco today.

LOST

space in your building

FOUND

with

KRAMER

OUTDOOR COMPRESSOR

Why lose dollar-making storage and selling space to house compressors, when you can now use the Kramer Outdoor Compressor? The THERMOBANK COMPRESSOR SYSTEM is factory assembled, tested and run-in; it saves installation time and money.

The refrigeration industry again finds Kramer blazing a new path with its THERMOBANK SYSTEM—the original and only automatic re-evaporating, non-overloading, fastest hot gas defrost system—now engineered to perform unfailingly, not only in a heated space but in any unheated space or outside at any outdoor temperature.

WRITE FOR BULLETIN TC 406A

KRAMER TRENTON CO. Trenton 5, N.J.

45 YEARS OF CONTINUOUS ACHIEVEMENT IN HEAT TRANSFER

Late news highlights

BRI conference Arthur J. Hess, ASHRAE immediate Past President, will present the keynote address "What Is Pure Air?" at the session on Air Cleaning and Purification to be held April 6 in New York, N. Y., as part of the Building Research Institute Spring Conferences. Under the chairmanship of John E. Haines, also a Past President, the Conference will include speakers H. L. Barnebey (Odors: Classification, Detection and Removal), Louis C. McCabe (Removal of Air Contaminants), W. L. McGrath (New Concepts for Obtaining Better Air Quality), Finn J. Larson (Future Methods of Air Purification), and William Green (Air Purification in Hospitals).

New edition Prepared by the Southern California Chapter of ASHRAE, the second edition of "Recommended Outdoor Design Temperatures – Southern California, Arizona, Nevada" includes about 50 new localities, especially in Arizona, and corrected design wet bulb temperatures said to be both realistic and consistent. Copies of the report, which supersedes the first edition published in 1957, may be obtained from the Chapter Treasurer, B. Lee Hutchinson, 6824 Vineland Avenue, North Hollywood, Calif.

On soldering Comprehensive and authoritative, *Soldering Manual* contains information on all phases of soldering including new techniques brought about by recent advances in miniaturization. Published by the American Welding Society, copies of the 170-page volume are available from AWS, 33 West 39th Street, New York 18, N. Y. Price is $4 for ASHRAE members.

Liquid hydrogen refrigerator An automatic 300-watt capacity, closed-circuit, hydrogen refrigeration system developed by the National Bureau of Standards Cryogenic Engineering Laboratory in which hydrogen vapor from an evaporator will refrigerate a liquid hydrogen bubble chamber down to 27 degrees Kelvin (about –214 F) described in National Bureau of Standards Technical Note 38, is stated to be safer and more efficient than a hydrogen liquefier, remotely located. Copies of the 40-page report, PB 151397, "Design and Construction of a Liquid Hydrogen Temperature Refrigeration System" are available from the U. S. Department of Commerce, Office of Technical Services, Washington 25, D. C., for 75 cents.

Warehouse directory Listing 500 plants totalling 400,000,000 cu ft of refrigerated space located throughout the United States, Canada and several foreign countries, the 1960 Directory of Public Refrigerated Warehouses has been released by the National Association of Refrigerated Warehouses. Distributed free of charge to all users of public refrigerated warehousing space, the guide may be obtained by writing NARW, 1210 Tower Building, Washington 5, D. C.

Mild climates studied As part of its Mild Climate Research Program, the National Warm Air Heating and Air Conditioning Association will study those dry, high altitude areas with high day and low night temperatures and low rainfall and humidity. First phase of this research, which is an outgrowth of action taken by the Board of Trustees of the Association during its annual meeting last December, will explore eight problems considered most susceptible to immediate investigation; later, five additional matters will be examined.

IIR As stated in a 4-page leaflet made available by the International Institute of Refrigeration describing its organization and activities, including its various publications, the object of the organization is to "further in all countries the development of scientific research, the teaching and popularization of science and technology and the development of the uses of refrigeration, particularly in the field of food and agriculture, in industry and in the field of human health and hygiene." Information regarding the Institute, which was founded in 1909 and now numbers more than 40 member-countries, subscriptions to the Bulletin and applications for Associate Membership may be obtained from the Headquarters, 177, Boulevard Malesherbes, Paris (17e), France.

Engineering guide Describing opportunities in various fields of engineering, "Engineering Careers in Canada," 1959-60 edition, serves as a guide to students in selecting a career and later in their choice of employment. Published by the Engineering Institute of Canada, 2050 Mansfield St., Montreal 2, Que.

Scholarship board To be established as a nonprofit corporation to administer its present scholarship programs and solicit additional scholarships from industrial and engineering firms, the National Society of Professional Engineers will institute an Engineering Scholarship Board.

Television film Portraying the benefits of air conditioning and publicizing the ARI Unitary Air Conditioner Certification Program and Seal of Certification, "Weather or Not" has been produced as part of the television series sponsored by the National Association of Manufacturers, "Industry on Parade." The 13.5 minute film is scheduled to be shown on some 270 television stations in the United States and by 42 overseas stations. In many cities the program will also be shown to local schools following the telecast.

Industrial health discussed To be held in Rochester, N. Y., the 1960 Industrial Health Conference will comprise meetings of the following groups: American Conference of Governmental Industrial Hygienists, April 24-27; American Association of Industrial Dentists, April 25-27; American Industrial Hygiene Association, April 25-28; American Association of Industrial Nurses, April 26-28; and Industrial Medical Association, April 26-28. Among topics to be discussed at various sessions are industrial ventilation, noise control and air pollution.

Electronic medicine Expanding its activities in the field of electronic medicine, Minneapolis-Honeywell Regulator Co. has assigned specialists to a newly-formed medical instrumentation group that would take over work already under way in three divisions and would institute new development programs in cooperation with medical authorities.

Commission 2 will meet Tentatively set for June 10, the 1960 Reunion of Commission 2 of the International Institute of Refrigeration will take place in Yugoslavia. Topics to be covered at the meeting are heat transfer, instrumentation and heat insulation. Appropriate papers for presentation (2000 words maximum) are invited; a short summary (200 words) should be sent to Professor Carl F. Kayan, Columbia University, New York 27, N. Y., by April 15 to insure consideration in the program.

Expenditures for research Reporting upon Research and Development Expenditures of Selected Groups of Nonprofit Institutions, 1957, the February 1960 issue of Reviews of Research and Data on Development, published by the National Science Foundation, is available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.; price is 5 cents.

NOTICE TO MEMBERS OF THE 1960 ANNUAL MEETING

The 67th Annual Meeting of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., will convene at Vancouver, B. C., at 9:00 a.m., Monday, June 13, 1960.

Continuing through Wednesday, June 15, the meeting will include Technical Sessions covering Absorption Air Conditioning, Refrigerants, Thermoelectric Engineering and Heating. There will be a Domestic Refrigerator Engineering Symposium and others on Commercial Refrigeration and Air Conditioning. There will be several Forums on immediate industry problems.

New officers will be installed at the Welcome Luncheon on Monday, June 13.

Every member who can do so should plan to attend the Vancouver Meeting.

D. D. WILE
President

R. C. CROSS
Executive Secretary

salutes ..the greatest selling fo

● Don L. Titus
President
TITUS MFG. CORP.

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WATERLOO, IOWA

Gentlemen of the Air Conditioning Industry:

The success of any business depends greatly on the men who represent that firm in the field. It is their knowledge, hard work and service which help form a solid foundation for acceptance of the company's products...and hence growth of the company itself.

The wonderful co-operation, outstanding service and hard work of these representatives have helped give Titus air distribution products their great acceptance throughout the nation...and made the Titus name one of the best known in the industry.

We are proud to be served by such outstanding men in the air conditioning field.

May we suggest that if you have an air distribution problem...or desire something new and different in air distribution product design, that you contact your local Titus representative, pictured here. His knowledge and many years of experience...backed by the tremendous engineering, manufacturing and laboratory facilities of the Titus company, are your assurance of OUTSTANDING SERVICE.

Very sincerely,

Don and Bob Titus

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AIR EQUIPMENT DISTRIBUTORS OF WISC.
Milwaukee, Wisc.

● Richard H. Mandell
AIR HANDLING PRODUCTS COMPANY
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LAURENCE TRANT & COMPANY
Norfolk, Va.

Albert Weiss
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New York, N. Y.

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L. W. WORTHINGTON
Billings, Mont.

R. F. Zimmerman
R. F. ZIMMERMAN & CO., INC.
Shreveport, La.

Contact your TITUS representative

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Titus Air Distribution Products . . .

- Supply Air Grilles and Registers
- Return Air Grilles and Registers
- Round, Half-Round, Square Ceiling Diffusers
- Series TMD Square and Rectangular Ceiling Diffusers
- Series 200 Ceiling and Sidewall Grilles
- Door Grilles
- Gymnasium Grilles
- Residential & Commercial Baseboard Perimeter Diffusers

A COMPLETE LINE OF TITUS *EAGle-Line EXTRUDED ALUMINUM* AIR DISTRIBUTION PRODUCTS . . .

- Sidewall Supply Air Grilles and Registers
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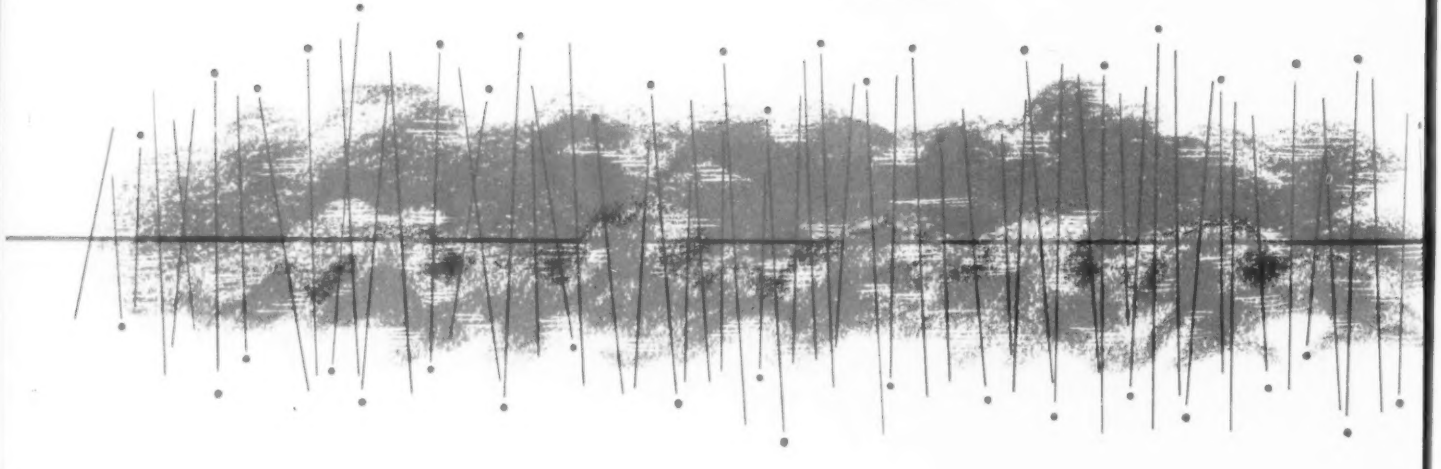
- Linear Convector Enclosures
- Security Grilles & Brick Vents
- 1½", 2" and 4" Outside Louvers
- Penthouses



TITUS MFG. CORP., Waterloo, Iowa
Miami, Florida

Climate by Chrysler

Blue Cross-Blue Shield Building, Detroit, Michigan. Air conditioning system designed and installed by W. T. Heany Co., Detroit.

Chrysler Packaged Air Conditioning cools Blue Cross-Blue Shield Building for $1.58 per sq. ft.

Question: What's the most economical way to keep 1700 people cool and comfortable in a building where there's no space for a large central air conditioning system? *Answer:* Build up a system of versatile, space-saving Chrysler Packaged Air Conditioners.

That's the method used in cooling Detroit's 7-story Blue Cross-Blue Shield Building. And the entire job was done with 62 Chrysler units for a total installed cost of only $1.58 per square foot of air conditioned space.

For large open work areas, strategically placed Chrysler Packaged Air Conditioners fit neatly against the building columns. Four-way air distribution keeps everyone comfortable and work efficiency up. For private offices, cool, filtered air is delivered through inexpensive ductwork.

The Blue Cross-Blue Shield Building is an outstanding example of two basic advantages of Chrysler Packaged Air Conditioning: Flexibility and economy. There are many, many more. To get the full story, or the technical cooperation of a Chrysler Air Conditioning engineer, write today.

CHRYSLER AIRTEMP

Airtemp Division, Chrysler Corporation, Dept. Z-40, Dayton 1, Ohio
Canadian Distributor: Therm-O-Rite Products, Ltd., Toronto, Ontario

PARTS and PRODUCTS

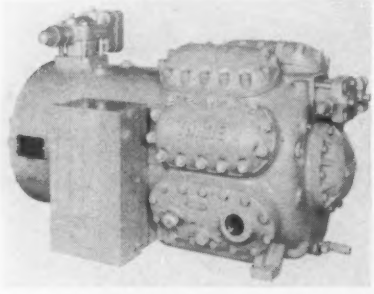
WATER COOLER

Based on the absorption method of electrical refrigeration, this cooler uses a small electric heater as a means of changing the refrigerant from a liquid to a gas and back to a liquid through a series of coils. Lightweight, it occupies less than one sq ft of floor space, has no moving parts and is silent in operation. It is capable of cooling to 50 F.

Arrowhead & Puritas Waters, Inc., Los Angeles, Calif.

HERMETIC COMPRESSOR

Fabricated in two cylinder sizes, both built into four, five, six and eight cylinder units, this is a hermetic model



of the manufacturer's Refrigerant 12 and 22 Reciprocating Refrigeration Compressor for air conditioning applications. Capacities from ten to 100 ton are provided by the units.

Instead of a split casing with a bolted joint between the motor and compressor, these units have a one-piece motor-compressor, which prevents a variation in the gap between stator and rotor, assuring proper motor operation. Smaller motors used to drive the compressor reduce the dimensions of the hermetic model. These motors are sized for max load at 45 F suction, 140 F condensing, with Refrigerant 22.

Trane Company, La Crosse, Wisc.

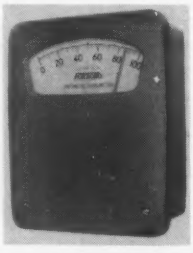
BRONZE GATE VALVES

Manufactured with a union bonnet and rising stem, these solder-joint valves are available in sizes ⅜ through 3 in. and have a pressure rating of 125 psi. Distortion caused by mechanical strain or temperature changes is cited as being eliminated by the union bonnet. With the exception of the body of these valves, designated No. 2SJ, all parts are interchangeable with the manufacturer's screwed-end, 125-psi rising stem gate valve of the same size.

Walworth Company, 750 Third Ave., New York 17, N. Y.

INDICATING TRANSMITTERS

Designated Model 45 Series, this line of pneumatic indicating transmitters for pressure, flow, temperature, liquid level, differential pressure and dew point features measuring elements specifically designed for each major process variable. Measuring elements in the following

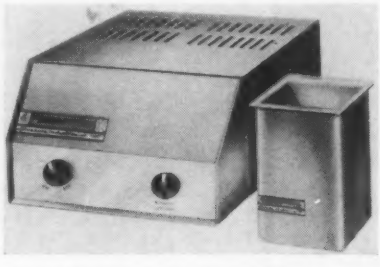


ranges are available: pressure—zero to ten in. water to zero to 80,000 psi; temperature—450 to 1000 F; flow (differential pressure)—zero to one to zero to 400 in. water; liquid level—open vessels zero to ten in. water min, closed vessels zero to 20 in. water min; and dew point— —50 to 165 F. Output signal is three to 15 psi (three to 27 psi optional) and the transmitter operates on a 20 psi air supply.

Foxboro Company, Foxboro, Mass.

ULTRASONIC CLEANER

Disintegrating more than fifty distinct classes of soils and contaminants from many different products ranging from surgical instruments to electronic components, System Forty includes Model G-40C1, a 40-watt generator with an output of 90,000 cycle/sec, cited as



being the proper frequency for small parts cleaning.

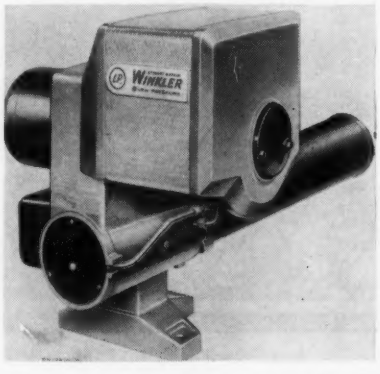
Source for the generator is 117 volt, 50/60 cycle current. Cleaning begins when the tank is filled with a suitable cleaning solution such as solvent or water and detergent and the switch is on. Integral with the tank is a transducer which converts electrical energy from the generator into sound waves of ultrasonic frequency. When this energy is propagated in the cleaning solution, the fluid is suddenly expanded into submicroscopic low pressure bubbles, which disintegrate soils clinging to the object to be cleaned.

Ultrasonic Industries, 141 Albertson Ave., Albertson, N. Y.

LOW PRESSURE BURNER

Contributing to the economy and comfort cited for the Winkler LP Oil Burner shown is the Heat-Keeper, a mechanical feature which prevents stand-by heat loss when the burner is off. Essentially an automatically operated air gate which opens as the burner starts, allowing enough air for complete combustion, it shuts when the burner turns off, preventing chimney draft from drawing residual heat from the boiler or furnace.

Controlling the firing rate is a positive displacement fuel meter, which can be sized to fit the heating plant, delivering the fixed amount of oil. Firing rate is not affected by dirt or oil viscosity. A fuel aerator builds up the proper operating pressure and mixes an exact amount of primary air



with an exact amount of oil. Oil-saturated air is then delivered to the nozzle where secondary air is introduced.

Having an orifice approximately 30 times larger than that of conventional high-pressure burner nozzles, the Turba-Nozzle is cited as being clog-proof, increasing burner efficiency.

Stewart-Warner Corporation, Lebanon, Ind.

REMOTE CONDITIONERS

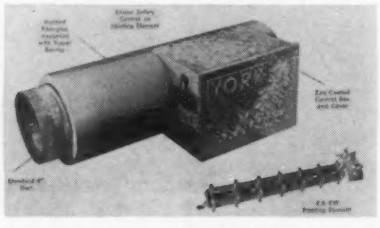
Built to fit most existing furnace types, these remote air conditioners are offered with a choice of four different coil shapes: angle coils for up-flow furnaces, A-shaped coils for up-flow furnaces where the duct system fans out in two directions from the top of the furnace, flat coils to go beneath counterflow furnaces used with per-

imeter heating systems and horizontal coils which may be placed anywhere in a horizontal run of duct. With an auxiliary blower unit, the horizontal coil adapts an underpowered heating system to cooling or makes possible an independent cooling system where no ducts exist or furnace ducts are not to be used. All coil units contain thermal expansion valve, suction, liquid and drain connections.

Placed outside the house, the compact air-cooled condenser is available in two, three, four and five hp and has an up-flow air movement. Refrigeration lines run inside the house to the coil unit mounted in the furnace plenum or air distribution duct.
Perfection Industries Div, Hupp Corporation, 1135 Ivanhoe Rd., Cleveland 10, Ohio.

DUCT HEATING SYSTEM

For use in residences in connection with a central air conditioning unit, this system consists of electric duct heating units installed directly in the air distribution system using the air moving equipment of a self-contained or remote air conditioner for distribution of the heated air. Use of individual duct heaters located immediately before the outlet diffuser in



the room, and controlled by a separate thermostat, allows for extensive flexibility in meeting individual heating requirements.

Featured in the system is a tempering heater located in the main duct at the fan outlet to take the chill out of air going to spaces where there is no need for additional heating. An interlocking relay is included in the assembly to prevent operation of the tempering heaters while the cooling unit is in operation.
York Div, Borg-Warner Corporation, York, Pa.

PRESSURE GAUGE

Designated Gearcoid Gauge Type 110, this heavy-duty, geared movement pressure gauge has been designed for a wide range of industrial applications. Recommended for oil, air, water, steam, gas or any other media not corrosive to brass or bronze, it is offered in 20 different standard ranges of zero to 15, 30, 60, 100, 160, 200, 300, 400, 500, 600, 800 and 1000 psi; compound ranges of 15/30, 30/30, 60/30, 100/30, 150/30 and 200/30 in vacuum; and in a vacuum range of 30 to zero in. vacuum.

Integral design of socket, tube, tip, movement, pointer and dial assembly permits installation by hand-turning the gauge case.
American Chain & Cable Company, Inc., Helicoid Gage Div, 929 Connecticut Ave., Bridgeport 2, Conn.

AIR-COOLED CONDENSERS

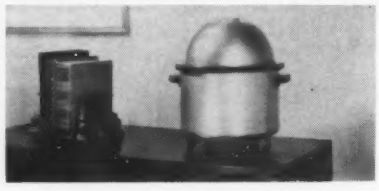
Horizontally mounted air-cooled condensers which present a low silhouette,

offer less wind resistance and a lower per-sq-ft roof loading than previous models are offered in 17 sizes, with the larger sizes of 60 to 100 ton capacity being furnished as double units manifolded together.

Fins are embossed with a pattern shaped and spaced to increase the efficiency of heat transfer, are of aluminum and have die-formed collars mechanically bonded to ⅝ in. OD seamless copper tubing. Four-blade deep-pitch fans are V-belt driven on permanently lubricated ball bearings and are vibration-proof mounted for quiet operation.
Acme Industries, Inc., 600 N. Mechanic St., Jackson, Mich.

HUMIDIFIER

Using minimal electricity and plugging into any electrical outlet, the Model 50 Mistalator is a portable



electric atomizing humidifier that operates on an aerosol principle. Water is atomized, at the rate of one pt/hr, into particles of five to ten micron by centrifugal force, producing a suspension of minute liquid particles in the air as fog or mist. It will adequately humidify areas up to 8000 cu ft.
Skuttle Manufacturing Company, Milford, Mich.

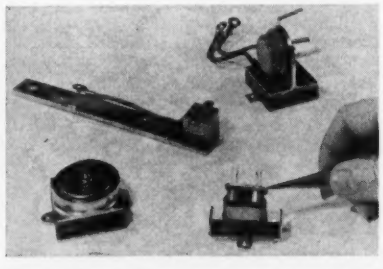
ABSORPTION UNIT LINE

Produced in 20 sizes ranging in capacity from 50 to 1000 ton, this new line offers a wider selection of heat-operated absorption refrigeration machines, featuring a control system cited as reducing operating costs, than previously offered.

An integral part of the new design is a solution valve control system, which offers savings through lower steam consumption when operating at partial capacity. It controls the cooling process by reconcentrating only enough salt solution to match the refrigerant load, electronically by-passing the rest. In addition to this, the control reduces the temperature of condenser water leaving the machine, decreasing scaling. Steam at 12 psi or less is used for the machine's full operating range, with no valves required to vary the pressure.
Carrier Corporation, Syracuse 1, N. Y.

THERMOELECTRIC MODULES

For use as electronic component coolers and in other applications where compactness, silent operation with no moving parts and a controlled cooling rate are desired, these modules are

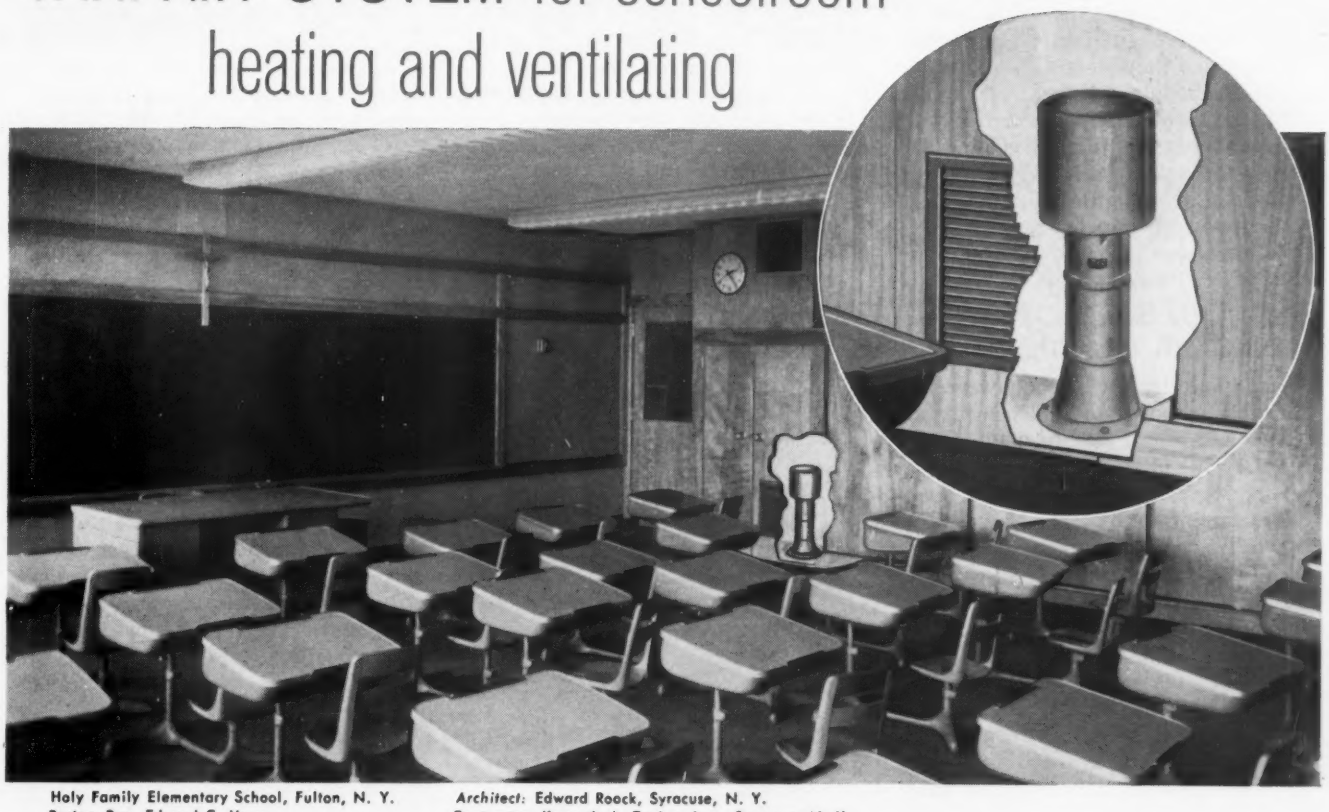


designed in a variety of shapes and sizes. Basic units can be physically paralleled to cool a large, flat area, or stacked in series for increased cooling.

Heat pumping capacity, or rate at which heat can be removed from the cold surface of the coolers, depends on the temperature difference between the hot and cold surfaces of the cooler and on the power input to the unit. To supplement the heat rejection capacity of the module, air or liquid cooling can be applied to the "hot" side of the thermoelectric cooler. In general, power at high input currents and low voltage is required. Current must be supplied from a dc source or a filtered rectifier output.

Adaptation of the units with different mounting fixtures for cooling vari-

VARI-AIR SYSTEM for schoolroom heating and ventilating



Holy Family Elementary School, Fulton, N. Y.
Pastor: Rev. Edward C. Hearn
Architect: Edward Roock, Syracuse, N. Y.
Contractor: Kenneth A. Taylor, Inc., Syracuse, N. Y.

MECHANICAL INSTALLATION @ $1.36 per sq. ft.

Vari-Air, a "split system" which handles ventilation requirements by a separate Vari-Air unit in each room, combined with Vari-Vac automatic temperature control system, provide a dozen plus features for new schools such as Holy Family Elementary School in Fulton, N.Y.

Foremost is the achievement of satisfying a basic concern of school planners everywhere . . . cost, without elimination of any design requirements. Citing actual facts, not general claims:

1. At Holy Family Elementary School, heating and ventilating cost was $1.36 per sq. ft. compared to 23,520 sq. ft. gross building area cost of $11.59 per sq. ft. This $1.36 figure represents considerably lower installation expense and amounts to a sizable saving on the aggregate.

Other advantages, important to school planners, include:

2. More free floor area per room.

3. Quick morning heat-up.

4. Designed percentage of fresh air to recirculated air guaranteed regardless of outside temperature change.

5. Complete flexibility of individual room temperature.

6. Elimination of classroom overheating due to student heat gain or sun heat gain.

7. Complete automatic control of heat input to schoolrooms through variation of steam temperature and volume, to agree with outside temperature change demands.

8. No down drafts from cold windows.

9. No drafts from air circulation.

10. No mechanical noise or mechanical maintenance requirements in schoolrooms.

11. Lower decorating costs through slight pressurization of buildings.

12. No technical training of maintenance personnel necessary.

Vari-Vac and Vari-Air systems, manufactured by Dunham-Bush, illustrate the advantages of a single source and delegating a single manufacturer responsibility. For instance, Dunham-Bush products at Holy Family Elementary School include: Vari-Air units; Radiation; Duplex Vacuum Pump with Differential controllers; air handling unit; Vari-Vac temperature controls; Steam Specialties including float and thermostatic traps, strainers, oriflex valves, and orifice plates.

If you're planning a new school or modernization, write for full details on Vari-Air and Vari-Vac.

Only Dunham-Bush can give you the advantages of a Vari-Air system.

Dunham-Bush, Inc.

WEST HARTFORD 10 • CONNECTICUT • U. S. A.

DUNHAM-BUSH

AIR CONDITIONING • REFRIGERATION • HEATING • HEAT TRANSFER

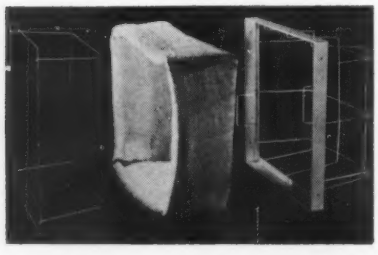
WEST HARTFORD, CONNECTICUT • MICHIGAN CITY, INDIANA
MARSHALLTOWN, IOWA • RIVERSIDE, CALIFORNIA
SUBSIDIARIES
heat-x HEAT-X, INC. BREWSTER, N.Y.
DUNHAM-BUSH (CANADA), LTD. TORONTO, CANADA
DUNHAM-BUSH (EUROPE) LTD. PORTSMOUTH, ENGLAND
BRUNNER MANUFACTURING (CANADA) LTD. PORT HOPE, ONTARIO

ous sizes and types of transistors is shown here. In the right foreground, a unit with cover removed exhibits a mounting configuration for chamber-cooling two transistors. Clockwise are: a basic module adapted for cooling four transistors; a smaller device with a chamber-type fitting for cooling one transistor; and a basic 1½-in. module adapted with a fitting for mounting a high-power transistor.
Westinghouse Electric Corporation, Box 2278, Pittsburgh 30, Pa.

CUBIC AIR FILTER

Combining high efficiency with low pressure drop, this replacement air filter utilizes a lightweight Dynel modacrylic filtering medium, a specially processed filter batt and open-side cube construction. Shaped like an open box, the Ulok filter is comprised of three components: a disposable high loft, two-in. thick filter medium; a retainer into which the medium fits; and a rust-proof retainer wire that fits inside the medium to hold it rigid (at left in the cut).

In operation, the air stream carries dirt into the cube to the front surface of the downstream face of the filter.



As dirt builds up on this face, air flow is shunted to the sides of the cube. Result of this is low pressure drop even after the filter has collected several pounds of dirt. Rated at 0.04 in. pressure drop at 2000 cfm, units are available with standard face areas measuring 20 x 20, 20 x 25, 16 x 20 and 16 x 25 in.
Union Carbide Development Company, Div of Union Carbide Corporation, 30 E. 42nd St., New York 17, New York.

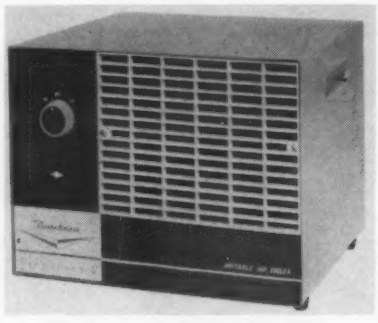
TWO-POLE MOTOR

Designed for such applications as domestic freezer and refrigerator evaporators, electronic equipment fans and other small fhp component motor applications where long life without maintenance is required, a permanently lubricated, small shaded-pole motor has been added to the Unitized motor line of this manufacturer.

Designated Type KSB33-frame, the units are rated from 1 to 20 milli hp, single-phase, 115 volt, 60 cycle, 3000 rpm, open or enclosed. Two basic versions are available, one for horizontal mounting applications which have only light axial end-thrust loads, the other for all-angle mounting applications which require a motor to handle axial end-thrust loads exceeding the "free end play" motor.
General Electric Company, Schenectady 5, N. Y.

PORTABLE AIR COOLERS

Two coolers, designated Satellite I and II, have been added to this line of portables. Weighing only 25 lb, the units, shown here, feature direct drive



pump, flow control valve to regulate cooling and die-formed hand inserts for easy carrying. Rating of the units is 2000 fpm.
Dearborn Stove Company, 1700 W. Commerce, Dallas 22, Tex.

DUAL RANGE MANOMETER

For use either as a vertical U-tube manometer or as an inclined manometer in the measurement of low pressures, No. 1226 Dual Range Manometer has a special scale which allows reading high range measurements on the other leg when the gauge is inclined.

When used as a U-tube manometer, pressures or pressure differentials are measured from zero to 16 in. of water with minor scale divisions of 0.2 in. water. As an inclined gauge, it reads from 0.20 to zero to 2.60 in. of water with minor scale divisions of 0.02 in.

Construction is shatterproof and lightweight, with two flat magnetic mounting clips to hold the manometer to any steel surface. The U-tube is extruded from transparent Butyrate and the flexible connecting tube from clear Tygon.
F. W. Dwyer Manufacturing Company, P. O. Box 373, Michigan City, Indiana.

GAS-FIRED HEATERS

Compact heaters in three types—propeller and blower units and duct heaters—are available in a wide range, the first two coming in ten sizes from 30,000 to 250,000 Btu input capacities and the latter available in six sizes from 60,000 to 250,000 Btu.

Featured in this line are all-welded, aluminized steel heat exchangers which are readily removable for cleaning and specially designed fans with oblong-contour blades for use on the propeller unit heaters. Blower and propeller units are equipped with two highly sensitive limit controls. One delays operation of the fan until the heat exchanger reaches the correct temperature to avoid drafts on start-up, and the other turns the fan off after all heat has left the exchanger.
Trane Company, La Crosse, Wisc.

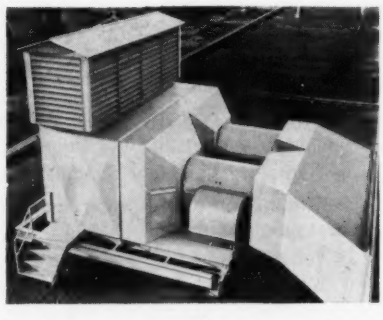
LEAKPROOF FABRIC

Strong and light-weight, this neoprene-coated asbestos fabric is impregnated with aluminum for greater strength and neater looking installations on flexible duct work. Available on all of this manufacturer's flexible duct connectors, "Neo-Bestos" is cited as offering the resistance to heat of asbestos combined with the airtight qualities of neoprene.
Elgen Manufacturing Corporation, 32-49 Gale Ave., Long Island City, New York.

GAS-FIRED UNIT

To supply warm replacement air in plants that are air-starved due to evacuation by exhaust systems venting fumes, gases and solid particles, this direct-gas-fired package unit operates automatically with a capacity of 150,000 cfm. Multiple installations are made with sufficient capacity to provide a pressure curtain at exhaust booths, thereby assuring required venting efficiency.

Air intake is from a four-direction louver tower giving ample air supply regardless of wind velocity or direction. Motor actuated dampers seal off ceiling air intake in combustion

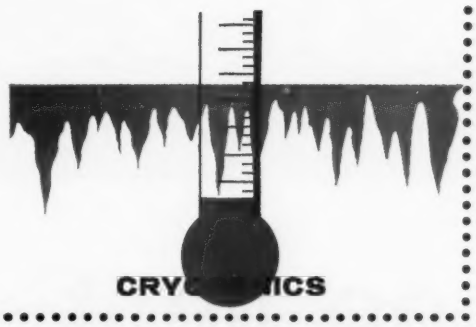


chamber, opening when the gas burner ignites.

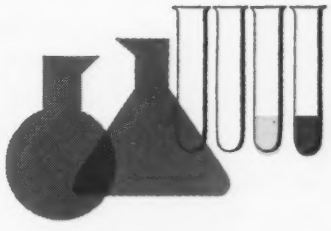
Automatically adjusting to control flame in direct relation to temperature changes is a 150,000,000-Btu Maxon gas burner, with stainless steel baffle wings that protect flame and disperse heat into air stream. Two

UNION CARBIDE announces a new personalized assistance program for air conditioning and refrigeration equipment manufacturers. Through your UCON Brand Refrigerants representative, CARBIDE offers you the experience of hundreds of specialists in cryogenics, metallurgy, chemistry and materials research.

Can CARBIDE technology help you find better lubricants? Help you solve special corrosion problems? Assist you in developing plastics and elastomers? See your UCON Refrigerants representative... and find out how this new personalized assistance program can work for YOU!

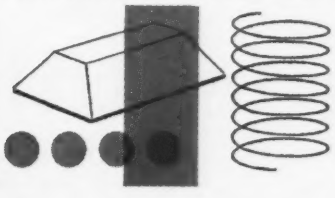


CRYOGENICS



CHEMISTRY

METALLURGY



MATERIALS RESEARCH

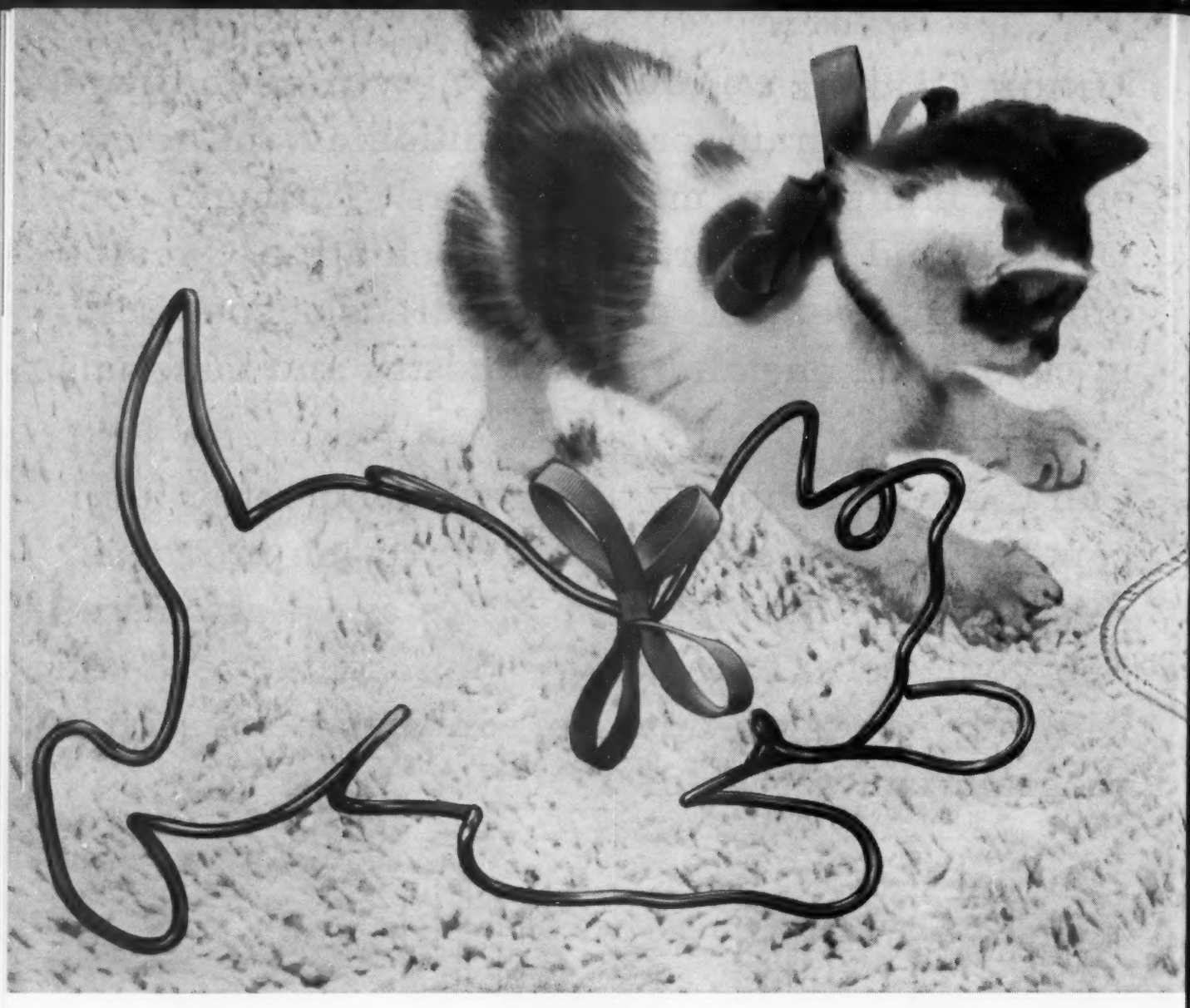
A new 96,000 square foot laboratory at Tarrytown, N. Y. will be an important part of CARBIDE's new assistance program. In this building, scientists and technicians from all areas of Union Carbide Chemicals Company's wide-ranging activities will pool their research experience to help you find practical answers to your problems. Your UCON Refrigerants representative makes this concentrated experience available to you, through CARBIDE's personalized assistance service. See him, soon! Call, write or wire UCON Refrigerants, Union Carbide Chemicals Company, 30 East 42nd Street, New York 17, N. Y.

UNION CARBIDE
UCON
BRAND
refrigerants

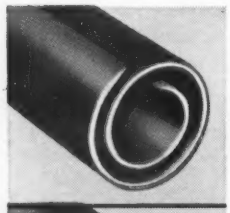
These 5 UCON Brand Refrigerants will meet your refrigeration and air conditioning needs

UCON Refrigerant 11 Trichloromonofluoromethane
UCON Refrigerant 12 Dichlorodifluoromethane
UCON Refrigerant 22 Monochlorodifluoromethane
UCON Refrigerant 113 Trichlorotrifluoroethane
UCON Refrigerant 114 Dichlorotetrafluoroethane

UNION CARBIDE CHEMICALS COMPANY *Division of Union Carbide Corporation*
30 East 42nd Street • New York 17, New York



There's almost no limit to the things Bundy can mass-fabricate



Bundyweld is the original tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to ⅝" O.D.

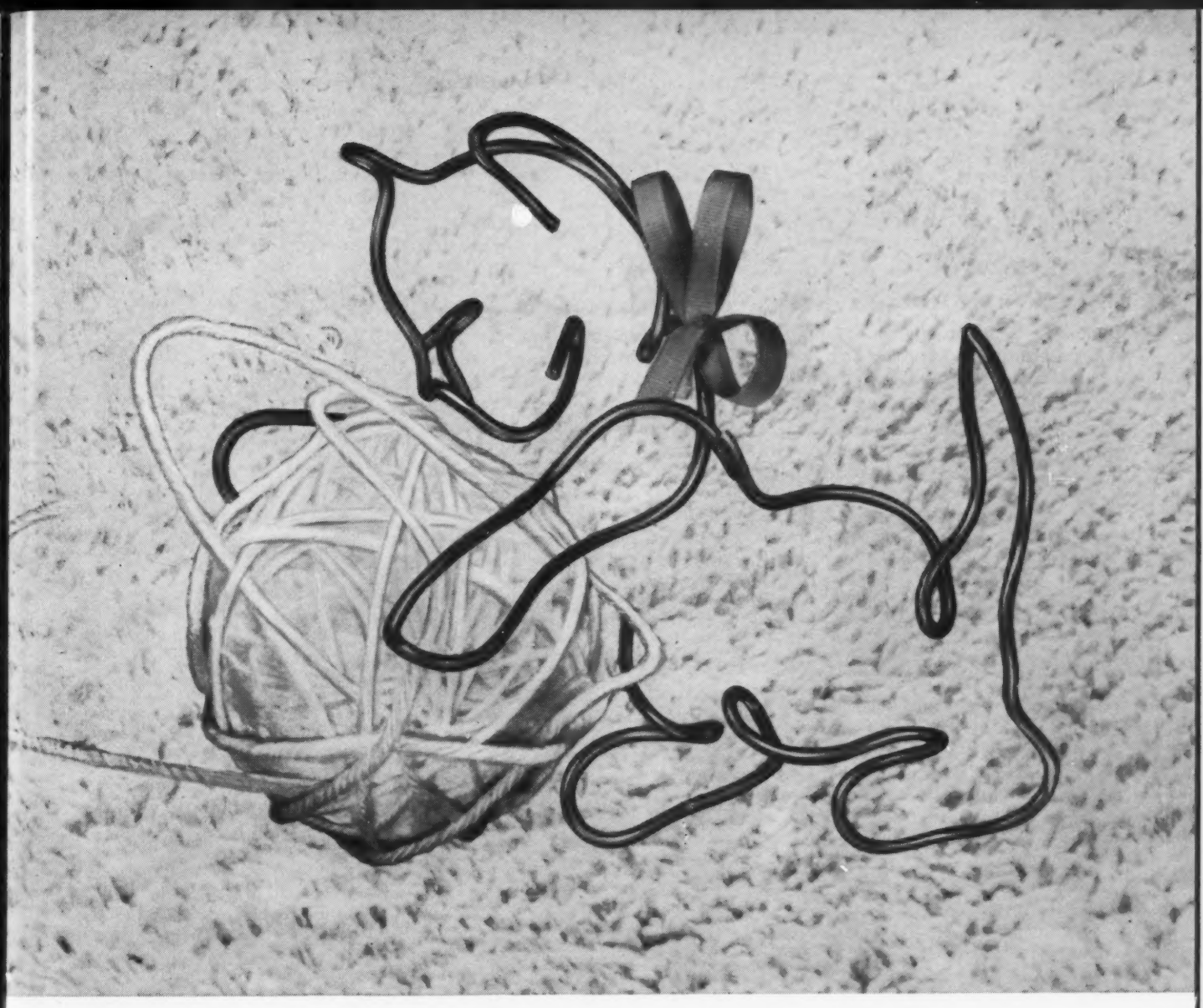
Experience makes the difference! Whatever your tubing problem, Bundy has the "know how" to mass-fabricate the shape you need.

Bundy engineers, working with you, may be able to suggest design modifications to cut fabrication costs. Then your design will be turned over to Bundy specialists who can mass-fabricate your tubing component at low unit cost with Bundyweld®.

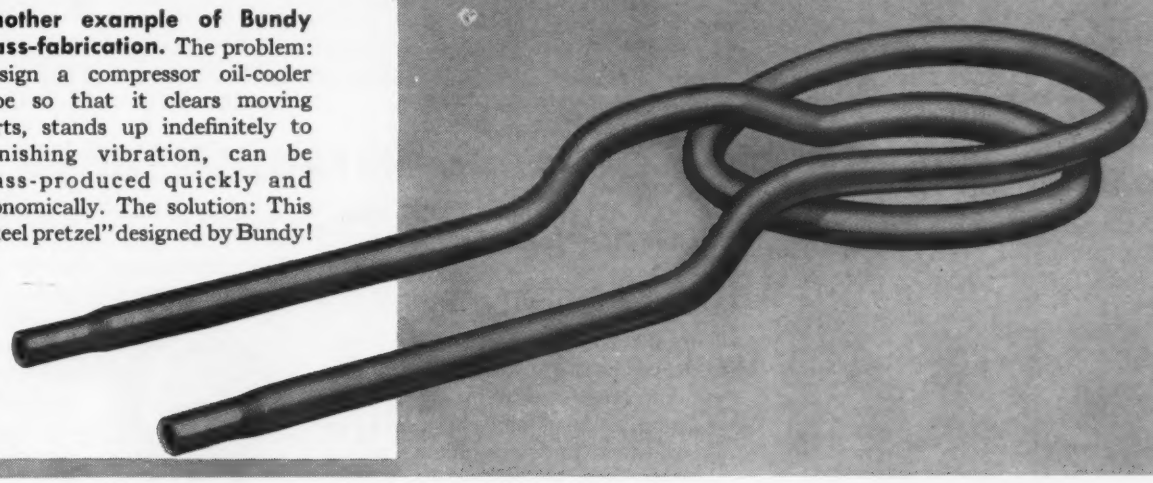
Bundyweld is the original steel tubing that's ***double-walled*** from a single steel strip for extra strength and resistance to vibration fatigue. It's the safety standard of the refrigeration industry. Bundyweld is covered by ASTM-254 and Govt. Spec. MIL-T-3520, Type III.

Got a tubing problem? Bring it to Bundy. Call, write, or wire: Bundy Tubing Company, Detroit 14, Michigan.

WORLD'S LARGEST PRODUCER OF REFRIGERATION TUBING



Another example of Bundy mass-fabrication. The problem: Design a compressor oil-cooler tube so that it clears moving parts, stands up indefinitely to punishing vibration, can be mass-produced quickly and economically. The solution: This "steel pretzel" designed by Bundy!



There's no substitute for the original

BUNDYWELD® TUBING

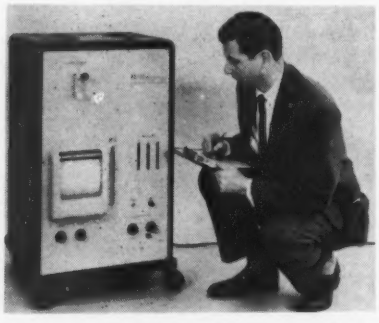
WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING • AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, AND ITALY

BUNDY TUBING COMPANY • DETROIT 14, MICH. • WINCHESTER, KY. • HOMETOWN, PA.

40-hp low-velocity axial fans pull air through combustion chamber into plenum and distribution chamber where individually adjustable 3 x 5-ft registers disperse the warm air.
Metals Engineering & Manufacturing Company, Inc., 8820 Lyndon, Detroit 38, Mich.

PARTICLE MONITOR

Monitoring outdoor air or atmospheres of indoor locations, such as ultra-clean work areas, this atmospheric-particle counting instrument



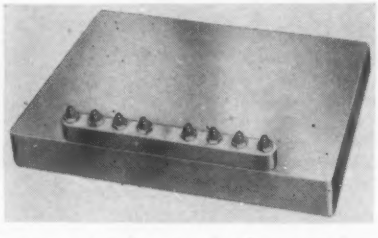
presents, on a strip-chart recorder, a permanent record of aerosols present in an overall range from 0.3 micron to any desired upper limit. This record is differentiated into 15 subranges and recorded in sequence at intervals which can be predetermined in length.

Included in the instrument is an alarm system which can be set for a remote indication of particle concentrations in any of the monitored subranges exceeding a predetermined maximum.

Counting rate of the PC-200 is 1000 particles per min with a one percent coincidence loss at the standard flow rate of 100 cc/min. Recordings are made on a six-in. strip chart at a standard movement of eight in./hr. Operation is from a 115 volt, 60 cps supply with a current of three amp.
Royco Instruments, Inc., 365 San Antonio Rd., Mountain View, Calif.

4-CIRCUIT ICE PLATE

Designed for cooling carbonated or non-carbonated beverages, the four-circuit, cast aluminum ice plate shown



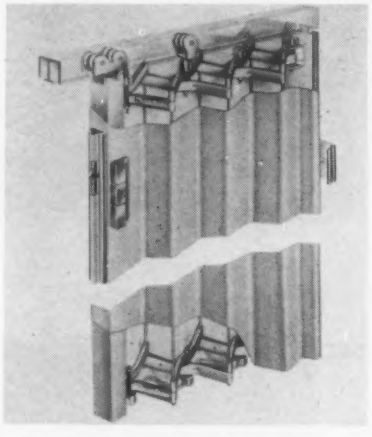
features stainless steel tubing, with replaceable-type connectors, embedded in a flat aluminum plate. Units are available in sizes from 8 x 12 to 18 x 20 in., with one to four circuits, and in capacities of 9 to 48 gph cooling, from 80 to 40 F.
Dunham-Bush, Inc., 179 South St., West Hartford, Conn.

DOWNFLOW GAS FURNACES

Included in this new line are three models designed for use in homes where cooling requirements are comparatively larger than heating. High capacity fans on the furnaces provide air volumes up to 1600 cfm for cooling, while ratings range from 77,000 to 115,000 Btu. When furnaces are used as central air conditioning units, fan cooling capacities range from 1100 to 1600 cfm for two, three and four-ton cooling units. Single speed ½ hp motors are provided for lower cfm requirements and two-speed ¾ hp motors for higher capacities.
Trane Company, La Crosse, Wisc.

FOLDING DOOR

Designed for use where more rigidity and less side sway are desirable, the Pantograph Door offers smooth, quiet operation, self-lubricating nylon wheels, anti-chatter I beam aluminum



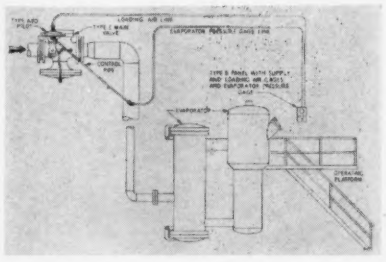
track, extra strong channel hinge, fabric covering snap-locked to steel frame and laminated nylon tape heat-sealed to covering to eliminate puckering and wrinkles.
Curtition Corporation, 12616 Chadron Ave., Hawthorne, Calif.

AIR-LOADED PILOTS

Control accuracy to within ½ psi from positive pressures through the vacuum range to 30 in. hg is cited as being made possible by a series of air-adjusted pressure pilots, which may be used in conjunction with a temperature recorder-controller for control of process temperatures.

Remote air loading of the pilot, designated Series A80, makes possible centralized control by locating the pressure adjusting panel at any convenient distance from the regulator. Mounting the pilot at the valve provides greater stability of control and consequent savings in fuels.

Depending on the type of pilot chosen, the delivery pressure is changed by one to two and two-thirds psi for each psi change in air loading pressure. With zero psi air loading, pilots A83, A84 and A85 will



control at as low as 28 in. hg, A80 down to 30 in. hg.

All A series pilots have bronze diaphragms. Cast iron, cast bronze and cast steel pilots are available in the series to handle maximum initial pressures as high as 600 psi and temperatures to 500 F.
Spence Engineering Company, Inc., Walden, N. Y.

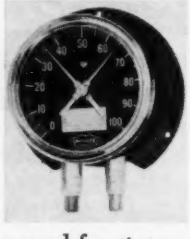
LOW TEMPERATURE COILS

Deltric Coils, which employ completely automatic electric defrosting, are now available for use in low temperature situations where light moisture loads are involved and may be used to obtain temperatures as low as −10 F.

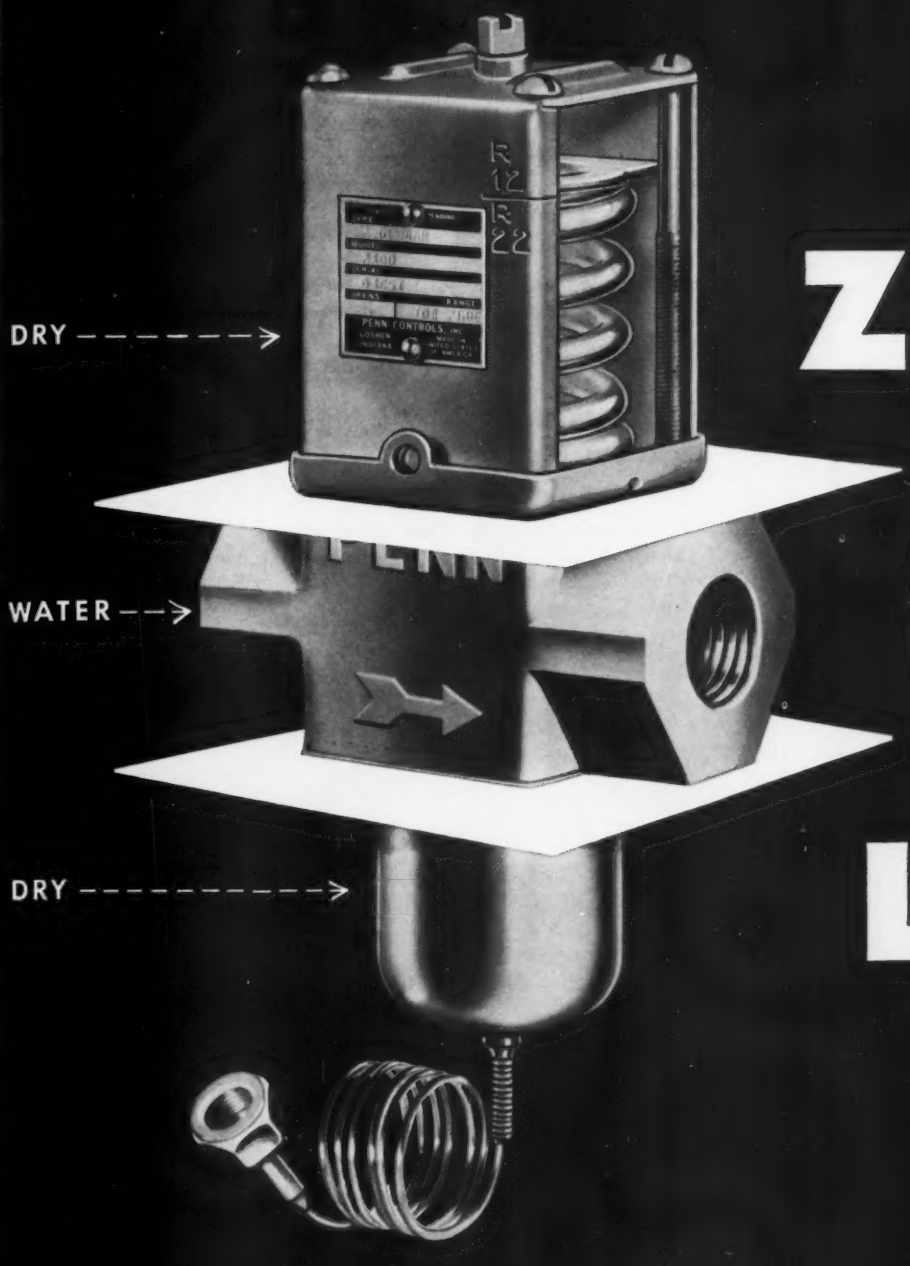
Designed for ceiling installation in either corner or back wall positions, these units obtain maximum efficiency during the defrost cycle by activation of the Thermovane door, which closes to hold heat during defrosting, swinging back out of the way during normal operation.
Recold Corporation, 7250 E. Slauson Ave., Los Angeles 22, Calif.

PRESSURE-VACUUM GAUGES

Enclosed in enameled aluminum cases with brass slip ring, these medium duty pressure and vacuum gauges feature guaranteed accuracy of 1% of



scale, bronze brushed rotary movement and adjustable pointer. Dial sizes are 3½, 4½, 6 and 8½-in. Types available are pressure-vacuum compound for steam, air, oil, gas or water and from 30 in. vacuum to 10,000 psi; combination pressure and temperature equivalents for Refrigerant



Zoned for Life!

IN THE PENN WATER VALVE... two diaphragms keep water away from the bellows, range spring and sliding parts. Water... with its rust, corrosion and sedimentation... never has a chance to attack these "working parts" and cause destruction. That's why the Penn 246 stays on the job longer than ordinary valves! Ask your wholesaler... he'll tell you the Series 246 is the best.

PENN CONTROLS, INC. Goshen, Indiana

EXPORT DIVISION: 27 E. 38th ST., NEW YORK, N.Y.

AUTOMATIC CONTROLS FOR HEATING, REFRIGERATION, AIR CONDITIONING, APPLIANCES, PUMPS, AIR COMPRESSORS, ENGINES

12 or 22; altitude – ft of water for tanks, reservoirs or hot water heating systems, and combination of ft of water and pressure scale; and duplex – two gauges in one case, two readings on one dial.
Weksler Instruments Corporation, Freeport, N. Y.

DIFFUSER DAMPER

Features of this ceiling diffuser damper include screw-type operator rack and pinion gear for opening and closing, screwdriver setting of the damper at

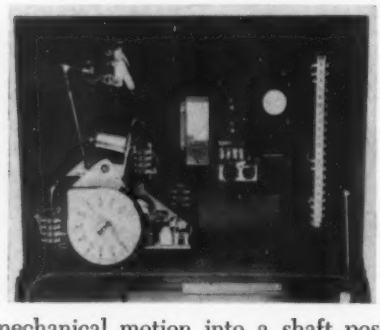
predetermined opening after installation, firm placement to eliminate rattle and no installation ring required.
Air Control Products, Inc., Coopersville, Mich.

ELECTRIC UNIT HEATERS

Use of a factory prewired, built-in 30 amp contactor relay in this line is cited as eliminating the need for remote contactors and external wiring. A thermal safety cut-out provides protection against overheating due to over-voltage, motor failure and other causes. Featured is a manual re-set to prevent damage from on-and-off cycling. Heaters are available in 5 and 7.5 kw capacities, 208, 240 and 480 volt.
Berko Electric Manufacturing Corporation, 212-40 Jamaica Ave., Queens Village 28, N. Y.

ELECTRONIC TRANSDUCER

For converting a measurement of pressure, liquid level, temperature or



mechanical motion into a shaft position for operating transmitting slidewires, alarm switches, analog to digital encoders and deviation contacts, the Dyna-Servo is a high-precision, high-torque electronic transducer.

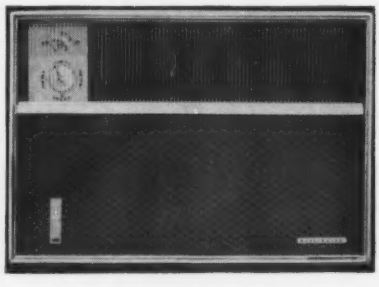
An amplifier is used by the electronic balancing system to operate a motor providing torque for positioning and the sensing element may be a capsular or helical element or a differential pressure unit. Motion transmitted from the sensing element through a linkage positions the core of a differential transformer. The coil is repositioned through a mechanical feedback system to return the electrical system to balance. Standard accuracy is $\pm 0.25\%$ of span.

Available attachments include: retransmitting slidewires, deviation detector for actuating digital transmission equipment, switches for alarms and a multi-position range-change switch for changing slidewire resistance.
Bristol Company, Waterbury 20, Conn.

1960 AIR CONDITIONERS

Eighteen models in four series, with a choice of four different cabinet sizes and a cooling capacity range from 4200 to 19,100 Btu/hr, are offered in this 1960 line of room air conditioners. Three models are available with all-season reverse cycle heat.

All units have metal fronts, cleanable filters with germicidal action, automatic thermostats and simplified



controls. Two-directional air flow control, permitting balanced circulation in all parts of the room or circulation of filtered air into two rooms at the same time, is included on all but the light-weight portable model.

Mounted in front of the unit is a signal showing white when the filter is clean and changing to red when the filter is clogged. An electro-magnetic filter is cited as capturing 95% of air-borne dirt, dust and pollen.
American Motors Corporation, Kelvinator Div, Detroit 32, Mich.

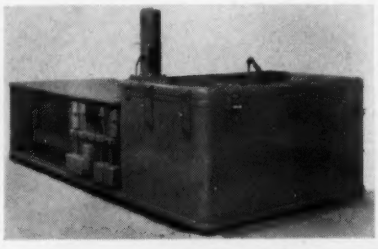
THREE-TON HEAT PUMP

Suitable for commercial and residential application, this three-ton, one-piece model in a weather-proof cabinet is similar to the two-ton model introduced a year ago. With an attached duct it can be mounted on the roof of a structure to heat and cool the interior either through a single large diffuser or through ductwork to individual rooms.

Auxiliary resistance heaters are prefabricated and slip onto the discharge side of the unit when needed. Summer and winter operation is controlled by a single thermostat which switches the heat pump from heating to cooling and back again without attention.
Carrier Corporation, Syracuse 1, N. Y.

CHILLING MACHINE

For stabilization of metal aircraft structures, this special low temperature production chilling machine has been designated Model 7SR-120-32. The chamber, utilizing a convection



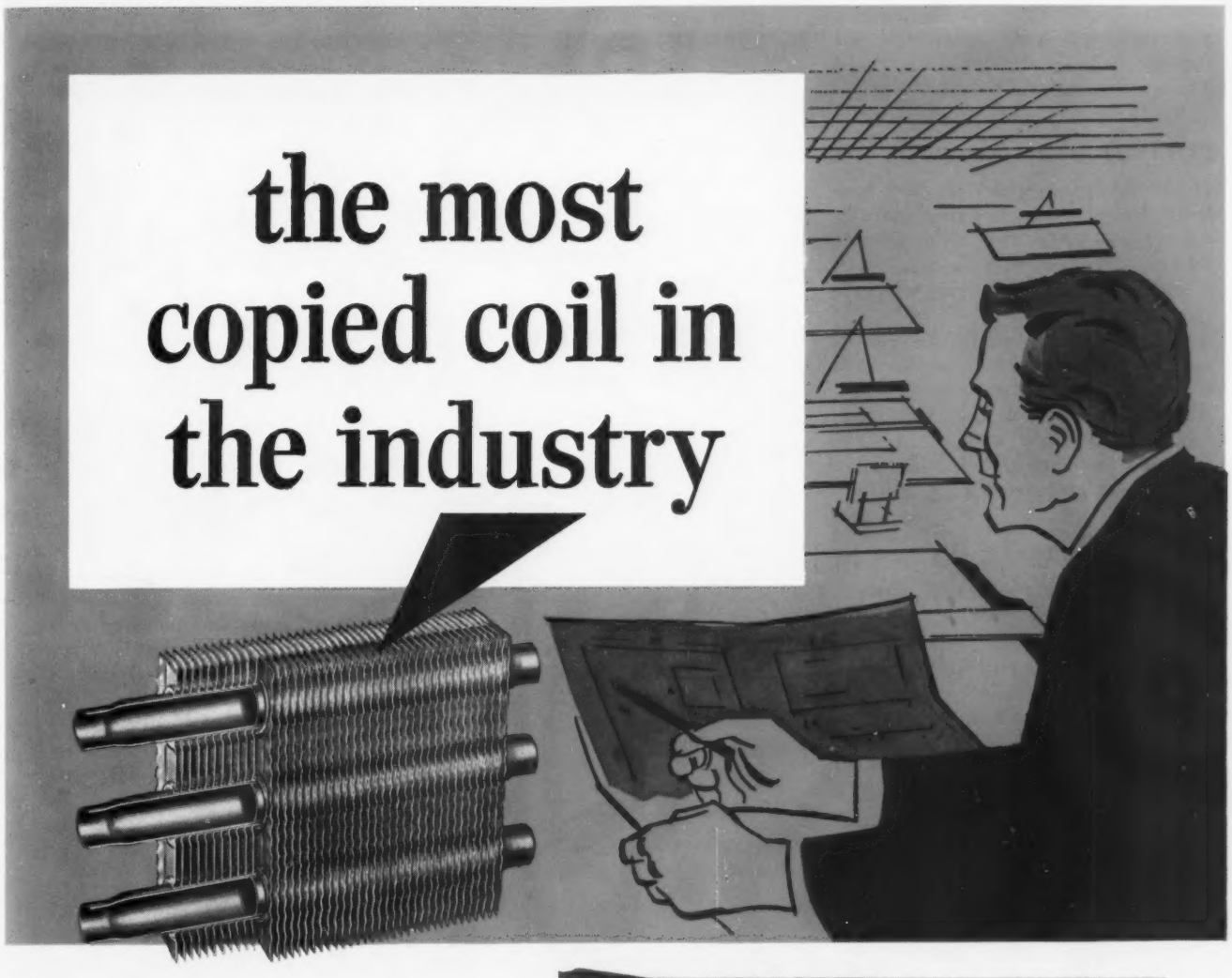
fluid for a more rapid uniform chill, has a max low temperature of –150 F and a thermal capacity of 14,000 Btu/hr at –120 F. With the prechilled liquid in the chamber, 500 lb of steel per hr can be chilled from ambient temperature to –110 F.

Parts to be chilled are placed in two 33 x 22 x 9-in. wire baskets, which are immersed in the convection fluid. Uniform temperatures are maintained throughout the liquid with a 1/3-hp vertical type agitator with draft tube assembly.
Cincinnati Sub-Zero Products, 3932 Reading Rd., Cincinnati 29, Ohio.

UNIT VENTILATORS

For use in schoolrooms, these compact (11⅝ in. deep) unit ventilators heat, ventilate and can provide complete year-round air conditioning. Possible variations of components and accessories allow selection to meet requirements of most climates. Five units are available for steam, hot water or electric heating: a heating and ventilating unit with valve control designed for either steam or hot water systems; heating and mechanical cooling unit with bypass control and dual coil design for chilled water cooling and hot water heating; heating unit with bypass control and four different hot water coils for an extensive range of heating capacities; heating and ventilating unit designed specifically for installation in milder climates; and a

the most copied coil in the industry

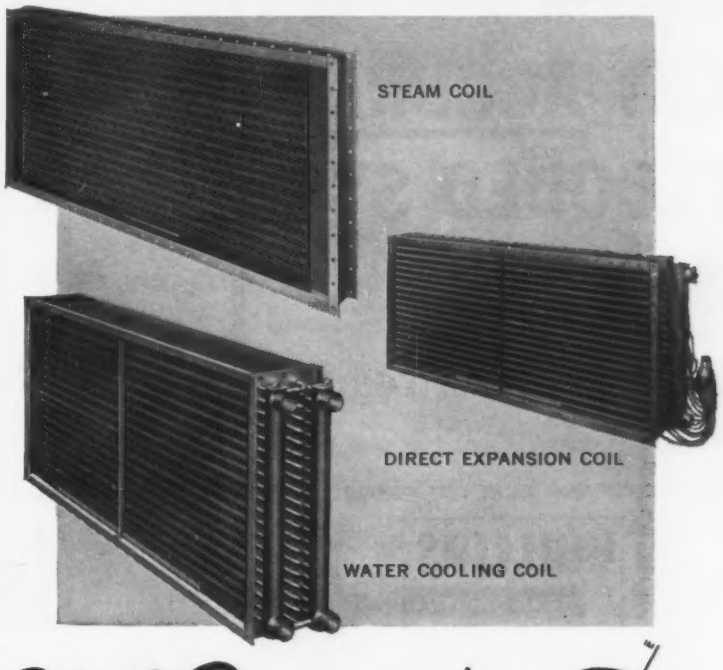


Over the years, McQuay coils have stood the important test of time, and have justly earned their reputation for quality and performance. No wonder, then, that they are the most copied coils in the industry.

McQuay was the first to produce a permanent fin-to-tube bond without the use of solder. McQuay was first with Ripple-Fins, first to combine Ripple-Fins and staggered tube construction for maximum heat transfer, greater strength and rigidity. McQuay, also, was first to add full fin collars to its Ripple-Fin construction for accurate fin spacing and maximum heat transfer.

McQuay coils are available in the widest possible range of styles and capacities and are available for steam, hot water, chilled water, direct expansion, refrigerant condensing and all types of brine. For any coil requirement, call your McQuay representative, or write McQuay, Inc., 1606 Broadway Street N. E., Minneapolis 13, Minnesota.

Tube diameters 5/8"—1/2"—3/8"
One to 12 rows deep—One to 15 fins per inch



McQuay Means Quality

McQuay INC.

AIR CONDITIONING • HEATING • REFRIGERATION

unit equipped with an electric resistance heating element.
Trane Company, La Crosse, Wisc.

COLD TRAP

Unlike flasks using dry ice and acetone, this cold trap is a mechanically refrigerated dewar flask automatically providing temperatures down to −140 F and maintaining its preset temperature unattended.

Weighing only 148 lb, the refrigeration unit is attached to the flask by a six-ft long flexible metal hose. All exterior surfaces vary little from room temperatures.
Serfass Corporation, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

ALUMINUM WALK-INS

Formerly available only with galvanized interiors and exteriors, this line of walk-in coolers and freezers is now being manufactured in aluminum as well.

All models are of sectional construction and easily and quickly erected; many are available with fully self-contained, hermetically sealed cooling and freezer systems.
Bally Case and Cooler Company, Bally, Pa.

CUTTER-DISPENSER

Incorporating a cutting assembly made of chrome-plated steel with a tempered and ground edge clamped on a clear plastics container, this dispenser for Thred-Tape Pipe Joint Sealer provides a simple and dirtproof means for handling the tape.
Crane Packing Company, 6400 Oakton St., Morton Grove, Ill.

VALVE ATTENUATOR

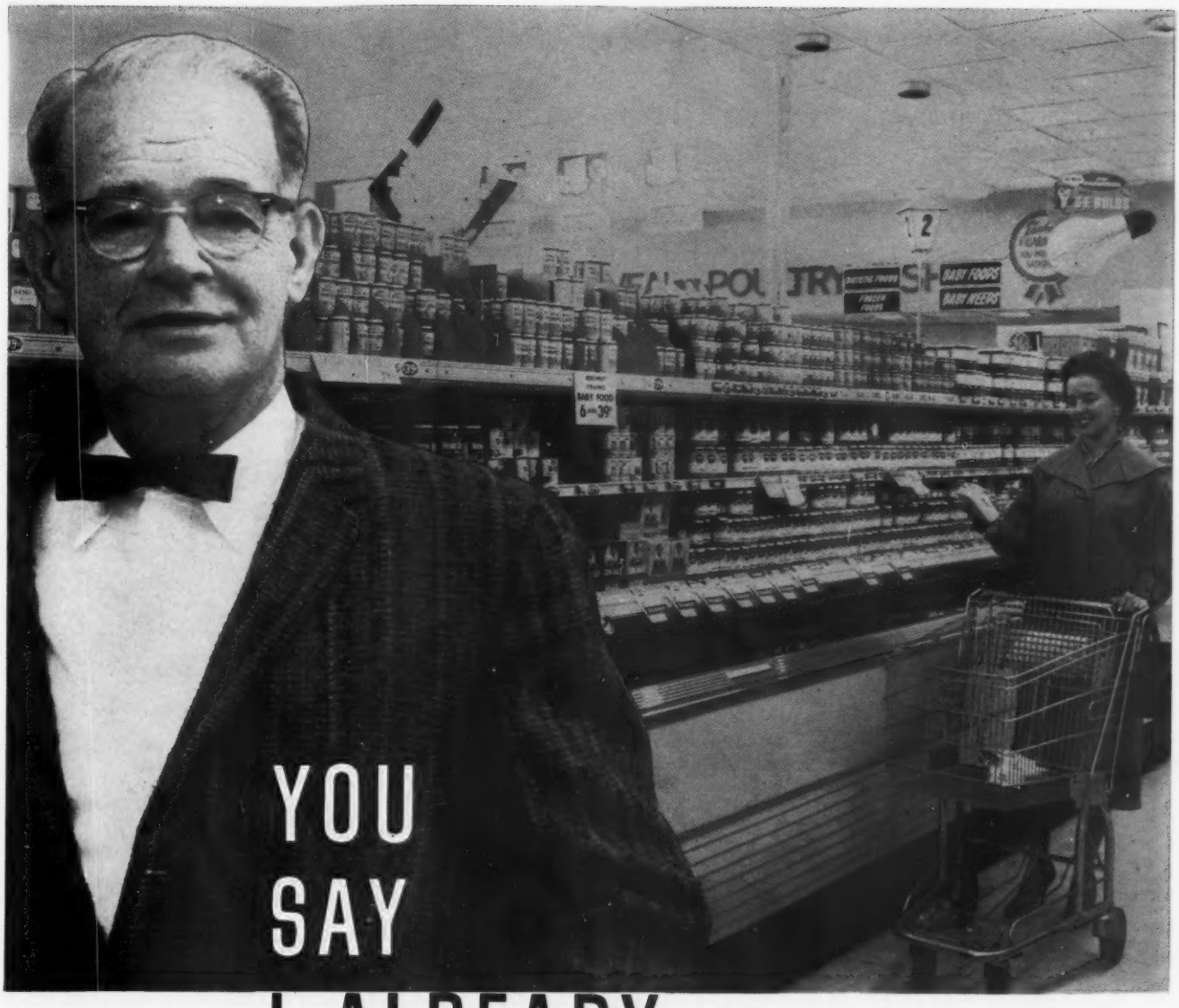
Features giving the Series 45P application advantage over motorized valves include direct pneumatic activation of valves and controls, eliminating the need for any motors or linkage; acute sensitivity to slight variation in control pressure; and positive comingling of hot and cold air streams, without stratification in air outlet. Designed especially for use in dual duct, constant volume high velocity air distribution systems, the unit's operation is quiet and it is calibrated for capacity determination.
Connor Engineering Corporation, Danbury, Conn.

EXPANSION TANK

A pressurized expansion tank cited as eliminating boiler water air absorption into the system and subsequent water logging of the tank, the modified Ex-Trol tank prevents system water from coming into contact with the air cushion by means of a flexible diaphragm within the tank creating a permanent barrier between the water and the cushion. The diaphragm is molded from a material compounded for high density and long life. Operation from any number of locations in the hot water system, and installation in any attitude relative to the line, are claimed for the tank.
American Tube Products, Inc., West Warwick, R. I.

WATER HEATERS

Two residential gas-fired water heaters, one with 75-gal storage capacity and one with 100-gal capacity, have been added to this line. Units are available with either galvanized or glass-lined tanks and are cited as having high recovery factors for heavy and continuous residential use. Design features include a single three-in., off-center flue instead of multiple flues and a vent that has been reduced from four to three in. for greater efficiency.
Pioneer Manufacturing Company, 3131 San Fernando Rd., Los Angeles 65, Calif.



I ALREADY DEPEND ON TECUMSEH?

If you own a home refrigerator, freezer, or air conditioner there is a better than even chance that you have at least one Tecumseh compressor. That you are probably unaware of this fact is proof in itself of the quiet, trouble-free service you are getting. Equally efficient performance is available in Tecumseh's new line of commercial compressors and condensing units. Why not consider Tecumseh your next refrigeration opportunity?

TECUMSEH

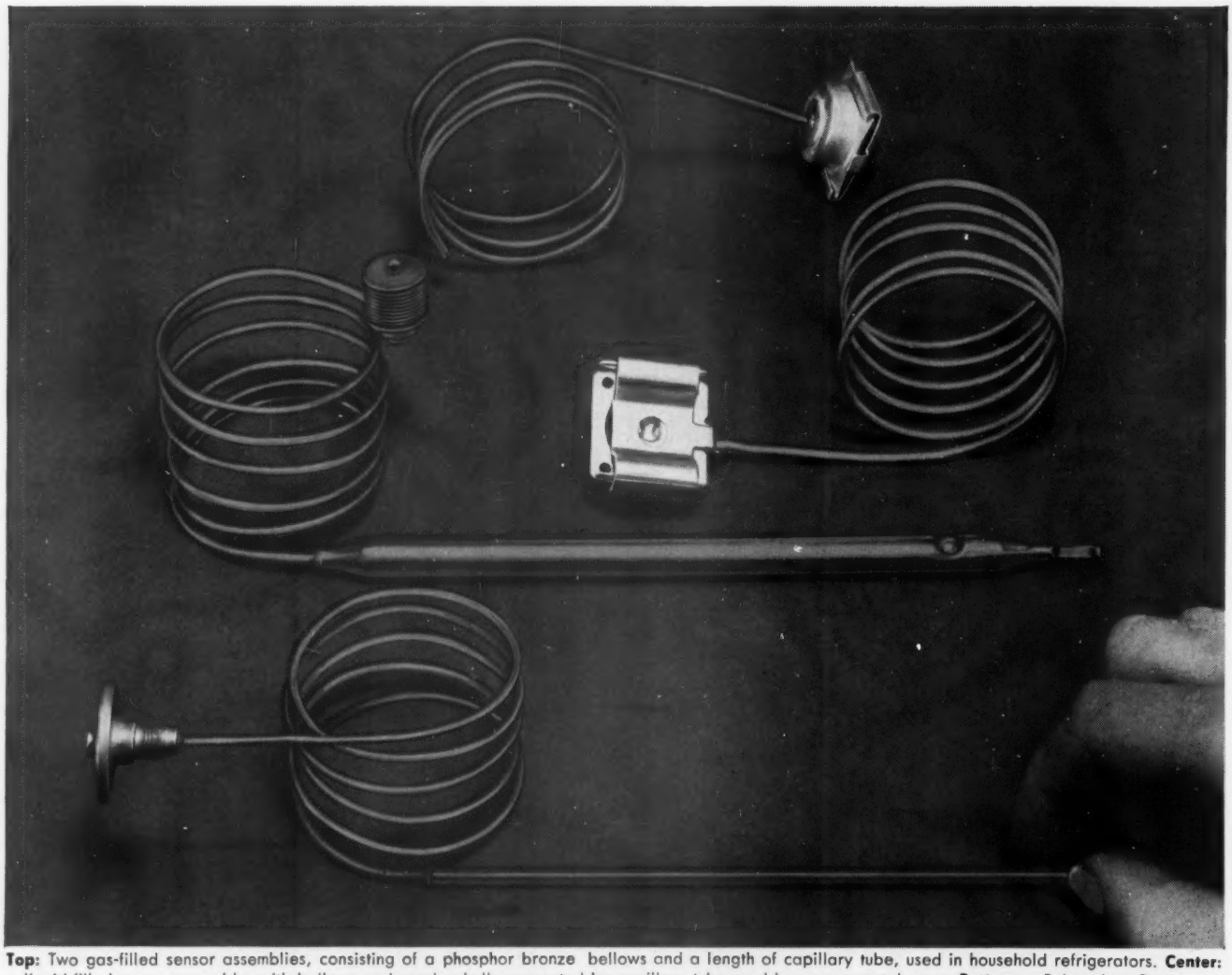
thirty seven million compressors in the field

The Leader Serving Leaders in the Air Conditioning and Refrigeration Industries

TECUMSEH PRODUCTS COMPANY

MARION, OHIO **TECUMSEH, MICHIGAN**

FOREIGN OPERATIONS DIV: Tecumseh, Michigan
CANADA: Tecumseh Products of Canada Limited, 1667 Dundas St., London, Ontario



Top: Two gas-filled sensor assemblies, consisting of a phosphor bronze bellows and a length of capillary tube, used in household refrigerators. **Center:** a liquid-filled sensor assembly, with bellows and sensing bulb connected by capillary tube used in a gas space heater. **Bottom:** a Robertshaw-Bridgeport Diastat heat sensing unit with diaphragm and sensing bulb connected by capillary tube, used in electric range oven controls.

Temperature sensors require high, uniform quality in capillary and bulb tube at Robertshaw-Bridgeport

The temperature sensing elements made by Bridgeport Thermostat Division of Robertshaw-Fulton Controls Company provide a simple and accurate means of controlling temperatures in refrigeration, air conditioning, heating, and cooking equipment. Important parts of these elements are furnished by French Small Tube Division of the American Brass Company.

Robertshaw-Bridgeport can provide manufacturers of controls and appliances consistently accurate calibration and dependable operation over long periods of uninterrupted service, largely because of the close precision quality of French capillary tube and fabricated sensing bulbs. These specially fabricated tube products must be scrupulously clean, meet strict dimensional specifications, and be free from flaws that would cause faulty operation. Robertshaw-Bridgeport also looks to the supplier for creative technical services to help meet the ever-changing needs of its customers as new models and applications come up. The French Small Tube Division of The American Brass Company, specialists in bulb and capillary tubing, have been consistently meeting these requirements.

Quality Tube and Creative Technical Services. Whether you need capillary tube, restrictor tube, bulb and tube assemblies—in either copper or aluminum—the French Small Tube Division has specialists to help you find the most economical way to do a job—the experience and facilities to turn out the tubing you need. For further information or technical assistance, write: French Small Tube Division, The American Brass Company, Box 1031, Waterbury, Connecticut. 8824

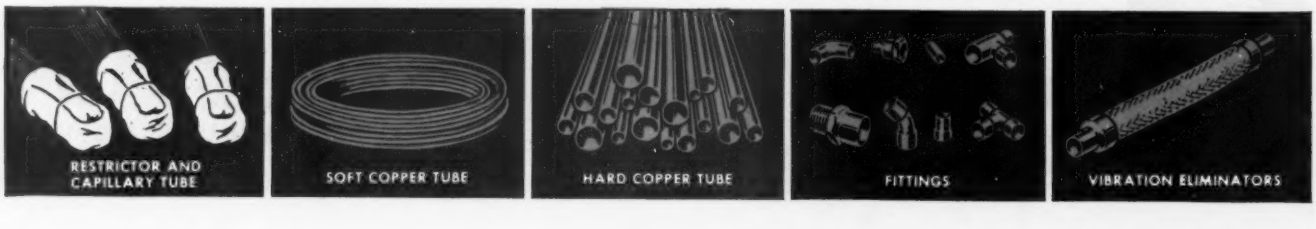
ANACONDA®

CAPILLARY AND RESTRICTOR TUBES

Made by French Small Tube Division of

THE AMERICAN BRASS COMPANY

ANACONDA PRODUCTS FOR THE REFRIGERATION AND AIR-CONDITIONING INDUSTRY



ASHRAE JOURNAL
OFFICIAL PUBLICATION
APRIL 1960

Are plastics worthwhile?

L. K. WARRICK
Member ASHRAE

Should plastics be used in refrigerators? What is to be done about the continuing public prejudice against plastics products? Manufacturing chemists, designers, plastics molders, plastics fabricators and engineers responsible for designing and producing today's domestic refrigerators and freezers, all have much at stake in the use of plastics. Namely, product quality, product leadership, and profits are directly involved.

Appliance sales managers find that plastics are a nuisance; that they have much harder jobs selling refrigerator lines which feature or use major quantities of plastics parts. Recently, a market research group ran a special survey with refrigerator dealers to find out what kind of refrigerators they, the dealers, would design and manufacture as being the most saleable. Here are some of these dealers' comments on plastics.

Dearborn, Michigan – Eliminate as much plastics as possible. Plastics are easily broken and become brittle in cold. Boxes should last 15 years. In three years interior plastics have deteriorated.

St. Paul, Minnesota – Customers think of plastics as the cheap, breakable kind in all instances; regardless of price, they want metal shelves and porcelain crispers. Plastics are unsatisfactory for any feature.

Detroit, Michigan, Department Store – Plastics are a poor substitute for metal. Plastics crack and do not last the life of the refrigerator.

Cincinnati, Ohio – The public objects to any plastics in the interior. They would rather have porcelain.

Columbus, Ohio – I might say women definitely do not like the plastics. The less plastics used, the better they like it.

Detroit, Michigan – Even in the less expensive boxes, our customers remark about not liking or not wanting plastics features.

Cincinnati, Ohio, Appliance Store– Eliminate plastics. We have complaints after the box is purchased. The change of temperature seems to cause plastics to crack.

Montgomery-Ferar, industrial designer, recently stated that the greatest problem facing designers today is the continuing public prejudice against plastics in quality products brought about by misapplication of these materials. Both designers and engineers need to lean over backwards to make certain that in their enthusiasm for new materials they are not using plastics improperly. Looking to the future, Mr. Ferar predicted the use of plastics foam insulation,

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These many years after the great plastics materials boom with its first promises, disillusionments and oft-renewed hopes, the ASHRAE Domestic Refrigerator Engineering Symposium at the Dallas Semiannual Meeting tackled some inherent and specific problems under the banner of "Should plastics be used in refrigerators?"

In collaboration with the Society of the Plastics Industry the Symposium was supplemented by an eight-man Question and Answer panel which sought to provide on-the-spot guidance to inquiries from the audience.

Here are the expressed views of Acting Chairman L. K. Warrick and speakers W. E. Brown and Dale Amos in considerably reduced form for this news report.

L. K. Warrick is Manager of the Advance Development Sub Section, Refrigeration Engineering, Hotpoint Div, General Electric Co.

whole interiors of plastics, and conceivable even a complete plastics door inside and out; noting that in Europe, right now, they are building all plastics refrigerators.

In view of this public prejudice against plastics, why do engineers and designers bother with plastics? Just this. Engineers have the responsibility to employers and to the public to be on the search for and to use new material developments in order to have high quality, low cost refrigerators and freezers, while at the same time maintaining or increasing profits. Only $10 is saved on the cost of a refrigerator whenever plastics are used instead of aluminum. In terms of sales prices, this saving means about $40 to $50 to the customer. It is heard repeatedly that the engineer is to blame for this public prejudice to the use of plastics and their bad reputation; that he is solely responsible for the use of plastics and that because of his poor judgment and shortsightedness, plastics usage is synonymous with second rate or low quality products. But the manufacturing chemists and the plastics molders and fabricators are as much to blame for this public prejudice as are the designer and the engineer.

The designer and engineer in fulfilling his public trust or responsibility must be constantly on the search for new materials, new ways to do things in order that he can engineer and design new refrigerators and freezers that will have greater eye appeal, greater utility, better usage at less service and less cost to the consumer, while at the same time maintain adequate profits for his company and its suppliers.

The manufacturing chemists are responsible for giving the engineers reliable, realistic material data and sound advice as to the right material to be specified for each part and part usage. The custom molder and fabricator has the responsibility to advise the engineer as to proper wall thickness, radii, transition sections and other design features that can be successfully molded.

PROBLEMS OF PLASTICS USAGE

1. Responsibility of vendors when bidding on sub-standard or poorly engineered and designed parts.
2. Finding, testing and specifying the right material for a part design.
3. Variation in molding resins from batch to batch as produced by the manufacturing chemists.
4. The degree of reliability of published physical properties of plastics materials as compared to published physical property data of metals.
5. Design characteristics of a well-designed and engineered plastics part.
6. Improvement in liaison between the engineer and designer with the molders, manufacturing chemists, and purchasing personnel.
7. Quality control checking methods that will enable the refrigerator manufacturers to insure that all parts made and all vendor shipments of plastics parts will meet or exceed minimum established quality standards.
8. Need for molders to refuse to bid on or to make parts they know by experience will not give satisfactory performance.
9. Underwriters laboratory requirements for plastics usage.

Plastics must meet the specific requirements

Properties of both plastics and metals are affected by temperature and time under load. However, the properties of plastics are usually affected more than are those of metals over the temperature ranges in which plastics normally are used. As a result, allowable design stresses for plastics must be selected based on the temperature and duration of load. Once these are established, the same design procedures are used whether the part is metal or plastics.

Performance of a plastics refrigerator part is determined in the (1) design of the part, (2) selection of the material, (3) design of the mold, (4) fabrication of the part,

WILLIAM E. BROWN

(5) assembly of the part in the appliance, (6) use of the appliance. Dissatisfaction is assured when any one of these factors is overlooked, slighted or distorted.

In most of these stages, the designer, the fabricator and the appliance manufacturer will be confronted with alternatives, the selection of which will be influenced by past experience, future objectives and available data.

Certain data sources will be important to the designer in making the original design. These can help in selecting the material. Still others may aid in design of the mold. Further data and still different methods should be useful during fabrication of the part as quality control tools.

It is important to note that these different types of data and the methods by which they are obtained predetermine their applicability to the stages listed above. Even more important is the fact that there exist considerable data on plastics from which the designer can calculate the size and shape of the plastics part required to give the performance desired.

Strength data over long periods — thousands of hours — has great value in many plastics appli-

William E. Brown is head of the Testing Sect, Plastics Technical Service, Dow Company. This paper, somewhat condensed for this news report, was presented at the Domestic Refrigerator Engineering Symposium, Dallas, Texas, February 1-4, 1960.

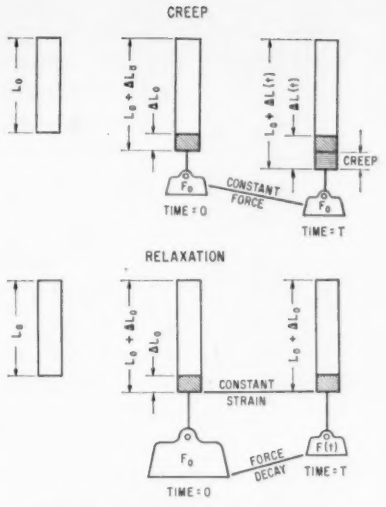


Fig. 1 Creep and relaxation in tension

Tests on a wide variety of materials have confirmed that the above equations for apparent modulus are applicable when the initial strain does not exceed that required to produce yield, which in most cases is less than 1%.

Both creep and relaxation can be measured quite accurately with relatively simple equipment. Fig. 2 shows a compact multiplying-lever system for measuring creep and Fig. 3 shows a similarly compact instrument for measuring stress relaxation.

Ultimate strength (stress at fracture) and elongation appear often, but their practical value must be questioned on the simple basis that few applications allow gross fracture as the criterion of failure. Yield stress, on the other hand, is a limiting stress in many applications and the designer should so use it.

Effects of Temperature – Thermoplastics, by their nature, change in properties as the temperature is varied. Low temperatures inhibit viscous flow while high temperatures promote it. Temperature therefore has effects analogous to time and speed and is sometimes used to estimate the effects of varying time and speed. For this reason, knowledge of both temperature and time and speed effects are strongly recommended for direct use in practical design problems.*

Presumably, any strength property is more valuable to the designer when determined over a range of use temperatures. True, but some strength properties are more important than others, because they are brought directly into play during use. Thus, the yield stress data in Fig. 4 and modulus data in Fig. 5 are of direct concern to designers and are shown here to emphasize their use. Note how differently the various materials react and particularly how the modulus curves cross one another.

Effects of Environment – Plastics, like all other materials, are influenced by their environment. We find especially that some gases and liquids may affect the strength of plastics under stress usually by embrittlement or plasticizer leaching but not always in a way detectable by short-time strength tests. Thermoplastics sometimes crack in certain environments at stresses lower than their yield strengths would lead one to anticipate.

Impact Stresses – Toughness is probably the most difficult term in plastics technology to define. It is difficult to define because: (1) it is a combination or the resultant of many other properties brought into play during use, (2) its connotation varies with the application.

Some have attempted to define toughness as if it were an inherent property measurable by one technique while others have tried to measure a number of properties and combine the results in a "toughness index." Still others have

Only realistic properties of plastics materials are of value to the design engineer. . . .

Misapplied data constitute a troublesome problem in the industry today. . . .

Facts obtained for one purpose should not be used for another without careful consideration of conditions at which they were obtained. . . .

Plastics like all other materials are influenced by their environment. . . .

Many methods for determining properties quantitatively will move out of research into design engineering. . . .

cations. For example, creep and creep rupture are data useful in long-time dead-load applications and stress relaxation data are pertinent to long-time constant-strain applications.

The use of such data is best illustrated by considering the definitions and mathematics of these two related phenomena. Creep is deformation under constant load. Relaxation is decay of force at constant strain. Both creep and relaxation are time and temperature-dependent. Fig. 1 shows how they appear physically.

It has been shown experimentally that the creep modulus and relaxation modulus are similar in magnitude and for design purposes may be assumed to be the same.

$$E_t \text{ (creep)} = E_t \text{ (relax)}$$

Therefore, only one time-dependent modulus, the apparent modulus, is necessary. The time-dependent moduli are defined as follows:

E_t (creep) = stress/strain at time

$$t = \frac{F_o/A_o}{\Delta L_t/L_o}$$

Where F_o = constant force, lb
A_o = original cross sectional area, sq in.
L_o = original length, in.
ΔL_t = increase in length at t, in.

E_t (relax) = stress at time t/strain

$$= \frac{F_t/A_o}{\Delta L_o/L_o}$$

Where A_o = original cross sectional area, sq in.
L_o = original length, in.
ΔL_o = initial deformation, in.
F_t = force at time t, lb.

* Time = duration of load.
* Speed = rate of loading.

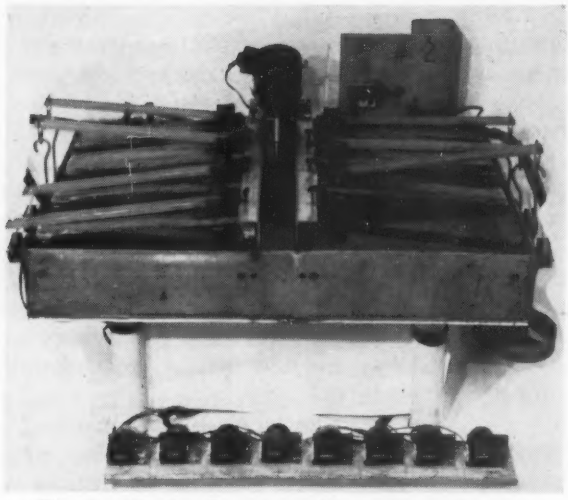


Fig. 2 Device for measuring creep and creep rupture in various environments

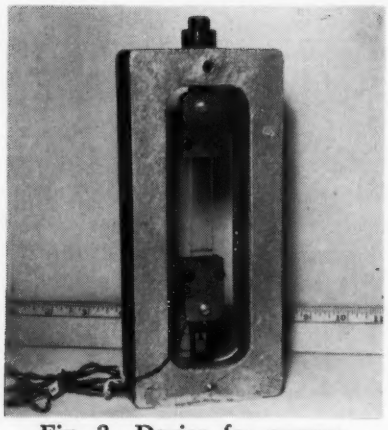


Fig. 3 Device for measuring stress relaxation

more correctly tried to define it for each application,

Fig. 6 shows how widely the conventional Izod impact method diverges from many common applications for plastics simply in the speed of impact. Fig. 7 shows the variation of Izod impact strength and falling missile impart strength of 0.125-in. thick specimens with cylinder (molding) temperature to be an apparent contradiction. Yet a little reflection will reveal that the lower temperatures promote molecular orientation and give high Izod impact results while the falling missile, acting polyaxially, finds the weakest link, the bonds between aligned molecules, and breaks them easily.

The Izod test puts the long dimension of the test specimen into complex flexure. Therefore, specimens oriented mainly in this direction should show higher impact strengths than specimens not so oriented.

Fig. 8 not only confirms this, but further shows how important it is to know in advance what direction the impact blow in service will assume with respect to the orientation in the molding before material selections are made. Small wonder, then, that impact strength results are often misleading.

Nonetheless, the Izod method can be modified readily to yield a measure of impact resistance in tension though the inherent limitation of a single speed at impact of about 11 fps remains. Tensile impact thus takes its place as a refinement and improvement but not an ultimate answer to the question of toughness.

Falling missile impact methods have several advantages over conventional Izod or Charpy methods. They include loading the specimen to failure not unlike the method of loading in many impact applications, the availability of various impact energies allied with the weight variation on the missile, the adaptability to measurements on entire moldings, loading the specimen or molding in such a way that the weakening effects of orientation are revealed and the possibility of at least some speed variation at impact through varying the height of fall.

Repeated Stresses – The most important repeated stress on plastics in refrigerators is the slamming of the door hundreds of thousands of times throughout the life of the refrigerator. The door slam test is a practical way to evaluate resistance of the whole refrigerator and all its components to slamming. No simulated use test has yet been devised to take its place. But door

Fig. 4 Yield stress of some commercial thermoplastics as a function of temperature (PE is polyethylene)

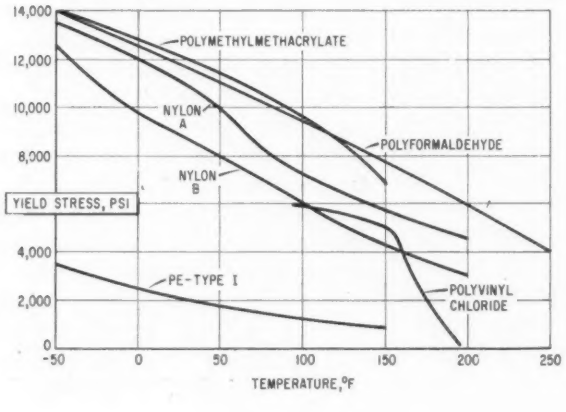
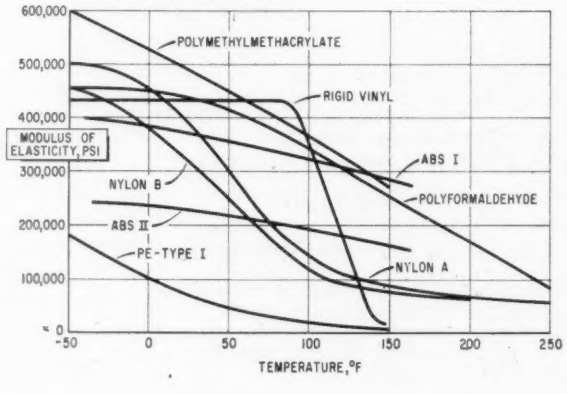


Fig. 5 Modulus of elasticity of some commercial thermoplastics as a function of temperature (ABS is acrylonitrile-butadiene-styrene. PE is polyethylene)



slam tests are slow, expensive and hard to reproduce. They are therefore not run often and are usually not considered the sole criteria of stamina anyway because their variations are not well understood.

In attempting to surmount these difficulties, calculations based on simple fatigue tests have been used.

Fatigue strength is the greatest stress a specimen, part or device can sustain for a given number of stress cycles without failure. Fatigue therefore implies a repeated stress.

Fatigue strength is sometimes erroneously thought to be the dead-load long-time strength, or the resistance to repeated impact loading. It must be remembered fatigue strength is determined at high frequencies, usually 1800 cycles per minute. It is therefore not realistic to apply fatigue data to all problems of strength just as it is not realistic to apply impact data to creep or creep data to stress cracking.

Fatigue strength of a part is extremely sensitive to stress concentrations. Therefore, S-N curves obtained on carefully-prepared specimens are only qualitatively useful to the designer for the selection of materials unless the S-N curves were obtained on the part in question. Design calculations based on fatigue strength as measured on simple shapes are not always reliable. In fatigue design, actual models should be constructed and tested.

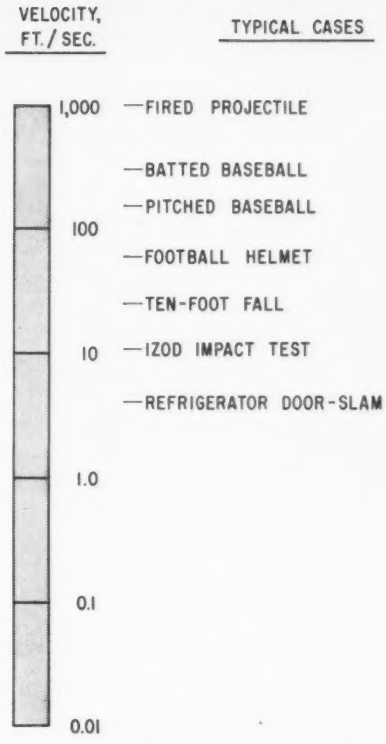


Fig. 6 Some typical velocities

Recent developments in adhesives and availability of better strain gages make it possible to apply these valuable tools to plastics. Thus, strain and stress distribution patterns can be determined on any part of a manufactured or mocked-up plastics item at any point in its manufacture, assembly or use.

Effects of static or slowly changing stresses can be recorded using a highly sensitive potentiometer or strain indicator. Dynamic or rapidly changing stresses can be observed with an oscilloscope and camera.

In one application of this versatile instrument a freezer flip lid was studied to determine the cause of breakage, the magnitude of stresses at failure and at what times in the history of the part the stresses were being imposed.

Strain gages were bonded to various critical areas of the flip lid and measurements were made of the strain in the parts during assembly and simulated service tests at temperatures at low as –20 F.

Failure (cracks, such as shown in Fig. 10) occurred because the mechanical and thermal applied stresses exceeded the design strength of the material. These applied stresses originated both in assembly and during use of the part. The primary source of stresses was the rigid bond between the metal and expanded plastics insulation which did not allow the plastics frame (to which strain gages are bonded) to act independently but rather restricted its movement. When the problem had been

TABLE I

RESISTANCE OF SOME COMMERCIAL PLASTICS TO VARIOUS CLASSES OF MATERIALS

Reagent	Plastics						
	Polystyrene	Styrene Acrylonitrile Copolymer	Polyethylene	Nylon	Polymethylmethacrylate	Polyformaldehyde	
Weak acids	Excellent	Excellent	Excellent	Fair	Excellent	Good	Excellent
Strong acids	Fair to Poor	Poor	Good	Poor	Good	Fair to Poor	Fair
Weak bases	Excellent	Excellent	Excellent	Fair	Good	Good	Excellent
Strong bases	Excellent	Excellent	Excellent	Poor	Fair	Fair to Poor	Excellent
Alcohols	Good	Fair	Excellent	Good	Fair	Excellent	Good
Esters	Poor	Poor	Good	Excellent	Poor	Excellent	Poor
Aliphatic hydrocarbons	Poor	Excellent	Excellent to Fair	Excellent	Fair	Excellent	Good
Aromatic hydrocarbons	Poor	Poor	Good to Poor	Excellent	Poor	Excellent	Poor
Foods and beverages	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Condiments	Good	Excellent	Excellent	Excellent	Excellent	Excellent	Good
Oils and waxes	Good	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent

Note—This table is nothing more than a guide for screening. In no case should these ratings take the place of specific data.

Ratings in Table I may be interpreted as follows:

Excellent	The plastics was unaffected in any way for the duration of the test. No significant strength loss. Expected life—years.
Good	A slight clouding or discoloration of the plastics took place. Expected life—months to years.
Fair	Moderate effect on the plastics. Slight etching, some discoloration, and possibly some dimensional change or weight change. Expected life—weeks to months.
Poor	Considerable change in plastics, noticeable visual effects, large strength losses. Expected life—days.

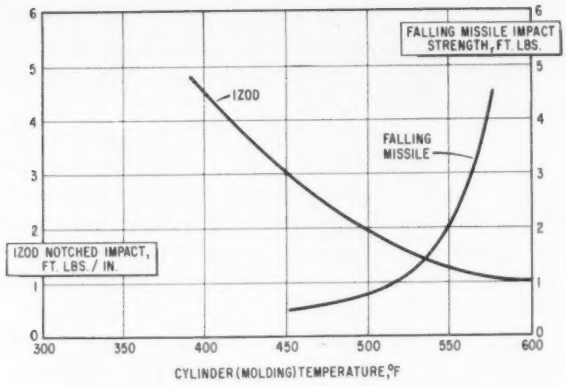


Fig. 7 Variation of Izod and falling missile impact strength test of a rubber-modified polystyrene with cylinder (molding) temperature

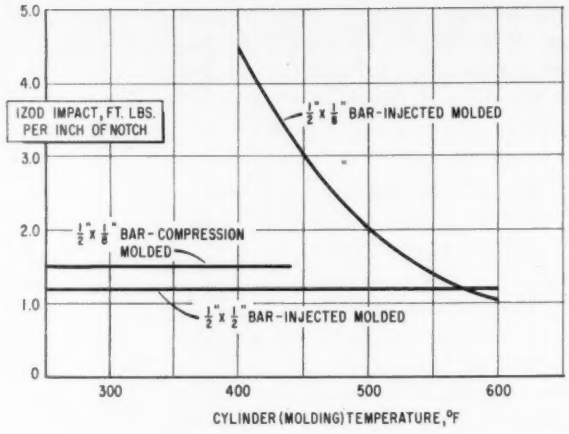


Fig. 8 Effect of cylinder temperature on Izod impact strength of a rubber-modified polystyrene

thoroughly analyzed in this manner the solution became self-evident.

The same technique applied to other plastics components can provide the following information:

Working load the part must carry
Source of load
Effects of design changes
Strength of the part
Location where failure is most likely to occur
Life expectancy of the part

Aside from chemical screening work, chemical resistance tests should be tailored to meet specific application requirements where possible. The best chemical resistance test for design purposes imposes the conditions of use on a prototype—obviously an expensive way to get the ultimate answer. Often, however, experience, judgment and general screening data can be relied upon to predict whether the plastics will succeed in the application.

A wide variety of tests made with the above principles in mind has shown those plastics in use in refrigerators to be highly resistant to practically all foods, beverages and condiments, but occasionally non-resistant to the cleaning agents, waxes, destaticizers and polishes often used in the production line. Fortunately, the agents used in production can be controlled.

In the rare cases where plastics are not resistant to refrigerated foods, beverages or condiments, it is usually in the form of staining, seldom in structural strength.

Table I lists some chemical resistance results for a few common classes of plastics and reagents. It should be emphasized that internal stresses produced in fabrication and external stresses in use may lead to stress cracking which cannot be evaluated by simply immersing a specimen in the environment. For the latter, quantitative stresses must be placed on the test-piece and their effects observed as function of time and temperature.

Form Stability at Elevated Temperatures—The most realistic measure of form stability at elevated temperatures is the dimensional integrity of the complete part or prototype in its intended use.

Such measurements can be expensive, wasteful afterthoughts of design engineering that must be overcome with some practical small-scale or laboratory tests of the material or specimens cut from the complete part. One such test is the deflection temperature.

Deflection temperature (the correct term for what was known erroneously as "heat distortion temperature") of plastics (ASTM D 648) is the temperature at which a specimen of certain dimensions deflects a specified amount when heated at a certain rate. It is, therefore, a special case of flexural strength and not necessarily a measure of heat resistance. Design applications for it are limited by its arbitrary nature, but of course it was never intended for design. It is nonetheless valuable in screening, quality control and specifications though its worth in all applications can be increased greatly by making a series of deflection temperature measurements over a wide range of loads, thereby producing a measure of load sensitivity.

Fig. 9 Apparent moduli of some commercial thermoplastics (73 F)

SAN—styrene-acryontrile copolymer. PMMA — polymethyl methacrylate. MPS — rubber-modified polystyrene. PFM — polyformaldehyde. NYL — Nylon. PE-1 — polyethylene.

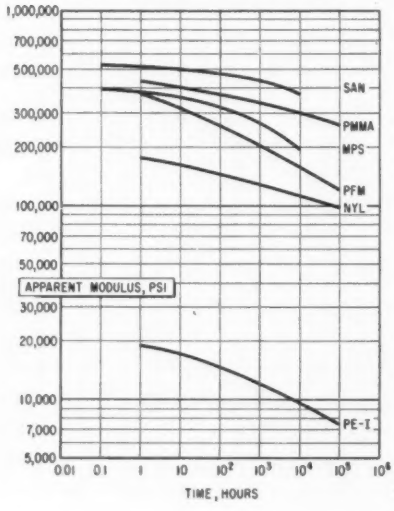
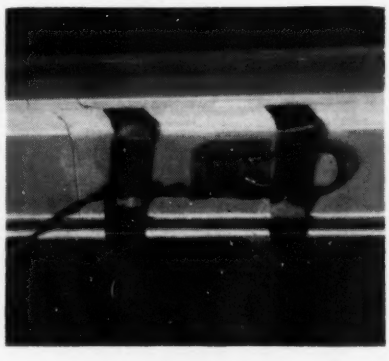


Fig. 10 Strain gage in place on a plastics component of a freezer flip-lid



It should not be assumed that this type of data is any indication of long-term load stability because most deflection temperature tests require less than one hour to reach the end point whereas many applications require much longer form stability. For the latter, long-term strength or modulus as functions of temperature are strongly recommended as the better criteria.

Future Developments of Information on Realistic Properties of Plastics – Common complaints around the industry are: (1) the normally published properties of plastics tell little if anything about how the material will perform in various applications, (2) lists of properties mislead designers and therefore have no legitimate place in published reference sources for use with plastics.

On one hand, we find the preponderance of plastics data a mere repetition of extension without qualification of what was originally intended for identification, specification or quality control. On the other hand, we hear many assertions, sometimes explicit but more often vague, that design and engineering data are needed in place of the other types. Still others claim that laboratory data do not correlate with field performance and therefore are not relevant anyway.

What then does the industry need? –First, the need to develop an understanding of the various types of data and their uses. A great deal of confusion can be disposed simply by properly classifying the many types of data now available, making sure that one type is not used as a poor replacement for another.

Second, empirical data and methods must be recognized as such and their place limited to identification, specification, or quality control. All too often a method well understood to be empirical in its early years loses this connotation and is later inadvertently applied in design.

Third, designers must be convinced that designing with plastics is no more difficult than designing with other engineering materials.

Most of the principles are the same. The data are different but no less reliable. Success of plastics applications is largely determined in the original design. Treating plastics design as art rather than engineering may well frustrate success.

How will these needs be satisfied? –Data necessary to design in plastics will lean strongly toward high speed loading at measured strain rates, stress relaxation from essentially zero time up to hundreds of thousands of hours, strength, stiffness and relaxation in biaxial loading, the effects of environment on strength and stiffness and the effects of temperature.

Many methods for determining properties quantitatively will move out of research into design engineering. Qualitative and empirical data will find a rapidly diminishing audience among designers. Strain gauges will be applied far more broadly and the accompanying stress analysis will become a commonly accepted part of a surprising number of previously empirical design jobs.

Specifications will become more end-product performance-oriented thereby broadening the possible selection of materials. There will likely be more pressure to include design engineering data in specifications and to exclude as much empirical data as possible.

Increased emphasis on compactness and light weight will put an extra burden on designers to work with newer, lighter materials such as expanded plastics. This shift will require implementation based on a detailed knowledge of realistic design and engineering properties of all materials.

I suggest that—

DALE AMOS

Instead of removing plastics from the box, they should be improved so that they will last that ten or fifteen year period desired.

It is the responsibility of the appliance manufacturer to understand the functions of the component part, both mechanical and visual.

The plastics industry recognizes its responsibility to use the latest processing technology and fabrication "know-how" available. Once the design is made, advance assurance of satisfactory performance is important. Testing procedures should be as accurate as possible. Thorough testing by engineering to benefit both manufacturing and quality control is also needed.

Plastics can not be the answer to every problem, especially when wall sections are reduced to such a point that the necessary physical properties are lost to do the given job. Too often wall sections have been reduced beyond the safety point due to the influence of the competitive market. This happened to the housewares and toy industries where in the early use of plastics shortly after the war, they experienced excessive breakage due to thin wall sections and poor design. Many of these applications failed. However, with the advent of the polyolefin materials, such as polyethylene, the housewife immediately accepted them. Many of the appliance manufacturers are using these polyolefin materials today in some applications.

NEED FOR KNOW-HOW

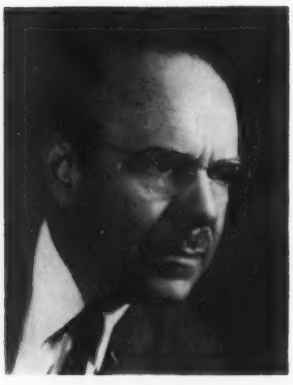
Plastics in many appliances have gotten out of hand. The purchasing and engineering of plastics products is a difficult task. Good technical up to date know-how is needed. It would be desirable for the purchasing and engineering departments to select two or three

(*Continued on page* 81)

Dale Amos is President of Amos Molded Plastics Div, Amos-Thompson Corporation and addressed the Domestic Refrigerator Symposium in a paper from which this condensation derives.

PRESIDENT'S PAGE
W. L. HOLLADAY
Guest Sponsor

ASHRAE Honors and Awards



W. L. HOLLADAY
Fellow ASHRAE

The Honors and Awards Committee "shall recommend to the Board of Directors the candidates for all awards for contributions to the sciences and arts of heating, refrigeration, air conditioning and ventilation, or closely allied fields, and for articles appearing in the official publication, and other gifts or awards including membership grades conferred as an honor."

These honors occur in three fields:

Personal

The F. Paul Anderson Medal may be awarded annually to a member of the Society for outstanding work done or services performed in the field of heating, ventilating or air conditioning. The fund was established in 1930 by the late Thornton Lewis in memory of F. Paul Anderson, President of ASHVE in 1927. There is a distinguished list of recipients; those still living include Dr. A. C. Willard, Prof. F. B. Rowley, Capt. A. E. Stacey, Jr., S. R. Lewis, E. N. McDonnell, C. S. Leopold, Prof. M. K. Fahnestock, Prof. G. L. Tuve and Prof. C. P. Yaglou. Does any reader have a name to propose for this honor?

W. L. Holladay, Chairman, ASHRAE Honors and Awards Committee, is a Consulting Engineer of Holladay & Westcott Engineers.

ASHAE-Homer Addams Award consists of a certificate and grant of $600 and may be awarded annually to a graduate student working on an ASHRAE research project. The award was established by the Addams family in memory of Homer Addams, President of ASHVE in 1924. This year's recipient is F. D. Farrington of the University of Arizona, who is doing research work on Noise in Liquid Flow Systems. Previous recipients are P. M. Chung, W. E. Springer and J. Y. Payton.

Senior members plaque is awarded annually to a teacher for outstanding service and achievement in teaching, by the Senior Members Club. More than one plaque may be awarded. This year's recipient is Prof. L. S. O'Bannon; former recipients are Prof. Linn Helander and Dr. Merl Baker.

Technical

The Wolverine Diamond Key is presented annually for the best paper published in the ASHRAE JOURNAL during the previous year. It was established in 1939 as a contribution to the industry by the Wolverine Div of Calumet & Hecla Consolidated Copper Co. and has been awarded to 21 authors for papers in Refrigerating Engineering and the present JOURNAL.

The Klixon Award may be presented annually for the best paper published in the ASHRAE JOURNAL pertaining to the electrical system as used in refrigerating or air conditioning. It was established in 1956 by the Spencer Thermostat Div of Metals and Controls Corp., and consists of a certificate and $150. Recipients have been E. W. Scott, R. T. Divers, H. O. Spauschus and R. S. Olson.

The Willis H. Carrier Award, consisting of a scroll and $250, may be awarded annually for the best paper presented at a national meeting by an Associate Member under 30 years of age. Established in 1958, no awards have yet been made.

Membership Grades

Honorary membership is awarded only rarely, for preeminent professional distinction. Present Honorary Members are Milton S. Eisenhower, A. C. Fieldner, Herbert Hoover, F. G. Keyes, and Rudolph Plank.

Presidential Member — all Past Presidents of ASHRAE or of either predecessor Society are Presidential Members.*

Life Member is a member who has rendered distinguished service to the Society, who has been a member for 30 years and who is 65 or older.

Fellow is a Member who has attained unusual distinction in any of the many facets of our industry, who is at least 45 and has been a Member for ten years or more. There are approximately 75 living Fellows, at least two of whom (C. S. Leopold, C. F. Kayan) attained this grade in both predecessor Societies.

Nominations for the three high grades of membership (other than Presidential Member) and for the F. Paul Anderson Award may be suggested to the Committee by any member of the Society. While the Committee has developed a searching technique which brings up names of those who, by the writing of papers, by work on committees or in other ways have served the Society well, this method does not establish "outstanding work or service," "unusual distinction," or "preeminent professional distinction." The Committee is most sincere in urging members thoughtfully to present names of those deserving of high honor.

* Does that make Arthur J. Hess three Presidential Members? *(Author)*

Activated charcoal for

Refrigerator odor control

should be in the air convection stream

AARON L. BRODY
Associate ASHRAE

JESS W. THOMAS

LOIS LAFEBER

Previously reported experiments in domestic refrigerators on problems in odor and odor transfer were conducted in units not equipped with forced air circulation. Since a large share of the American production of domestic refrigerators does incorporate this feature, it was felt that a re-evaluation of activated charcoal as an odor adsorbing agent in forced convection units would be desirable.

Essentially, it was necessary to measure two phenomena: odor level intensity in refrigerators, and odor transfer from one food to another. Odors of a number of different foods typical of those causing problems in domestic refrigerators were measured. Since it would have been prohibitively expensive to develop physical or chemical indicators of odor level for each food odor, subjective methods were used with one exception.

Odor level intensity was evaluated by both a subjective and an objective method. In the former, odorous air from the refrigerator was passed through one of a series of six tubes containing successively decreasing amounts of activated charcoal. To start the test, odorous air was passed for a few seconds through the tube containing the most charcoal. A trained panelist then sniffed the effluent gas from the tube. If no odor was detected, the gas stream was shifted to the tube containing the next largest amount of charcoal, the effluent was sniffed, and the process was continued until a definite threshold level of odor was perceived. Assignment of consecutive numbers to the tubes permitted a semi-quantitative subjective evaluation of the refrigerator odor intensity.

Jarvis and Ranum (1958) used a similar method, except that odorous air was passed through all tubes simultaneously and continuously. In the present method, activated charcoal was exposed to odorous air for only a few seconds for each determination. Basically, the Jarvis and Ranum method measured the quantity of odorous air required to partially saturate a given quantity of activated charcoal. In the present work, odor intensity level was measured, since a given quantity of activated charcoal arranged in a thin bed removes a definite proportion of odor in odorous air passing through the bed. In order to understand the basis of this phenomenon and its limitations, it is necessary to consider the fundamental mechanism of odor removal from a flowing air stream by a thin bed of adsorbent.

An odor molecule will be permanently removed from an air stream only if it (1) contacts the surface of the activated charcoal enroute through the activated charcoal bed; (2), adheres, that is, does not ricochet or be desorbed. These two phenomena are quite distinct and depend on different parameters. The transport of the odor molecule to the surface depends only on the diffusion constant of the odor molecule, air velocity, and dimensions of the activated charcoal bed and activated charcoal granule. Transport is independent of chemical nature of the adsorbent charcoal, or degree of charcoal activation. On the other hand, the quantity of gas that activated charcoal will hold is dependent on degree of charcoal activation, and of saturation of the charcoal bed.

Conditions in the activated charcoal odorometer were controlled so that the activated charcoal was far removed from saturation. Hence transport properties alone determined the fraction of odor getting through the activated charcoal bed. For a given odor, and given activated charcoal mesh size and air velocity, the fraction of odor removed should be a logarithmic function of bed thickness. Molecular properties of odor molecules are independent of the number (i.e., concentration) of odor molecules, which implies that the number of odor molecule collisions with the activated charcoal is proportional to odor molecule concentration, C. In a differential bed thickness, dz, therefore, there will

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A. L. Brody is a Food Technologist; J. W Thomas is a Chemical Engineer; and L. M. Lafeber is Home Economist, Research Laboratories, Whirlpool Corporation. This paper, here somewhat condensed, was presented as "Use of Activated Charcoal to Decrease Odor and Odor Transfer in Domestic Refrigerators" at the ASHRAE Semiannual Meeting in Dallas, Texas, February 1-4, 1960. The complete paper will appear in ASHRAE TRANSACTIONS.

be kC dz collisions with the activated charcoal, and -dC = kCdz.

Integration gives ln (C_1/C_2) = kz. As will be shown subsequently, this logarithmic relation holds.

To apply the activated charcoal tube method it is necessary to know the odor reduction factor for each tube. This was determined using acetic acid vapor as a representative odor.

Flow rate through all tubes was standardized at 4.5 1/min. Activated charcoal was 6 x 14 mesh, and amount in each tube varied from 0.75 to 3.75 gram in increments of 0.75 gram. Tests were made using both dry air and air saturated with water vapor. Acetic acid vapor was obtained by bubbling dry air through glacial acetic acid. After dilution with air to the required flow rate of 4.5 1/min., concentration samples influent and effluent to the tube under test were taken using 500 ml fritted glass bubblers. Water was used as the absorbing agent, and the resulting aqueous solution of acetic acid was titrated to the phenolphthalein end point with sodium hydroxide. Division of the influent bubbler titre by the effluent bubbler titre gave the odor reduction factor for each activated charcoal tube. Results shown in Fig. 1 indicated a logarithmic relationship between charcoal bed thickness (proportional to charcoal weight) and odor reduction factor (C_1/C_2). Reduction factor was 3 for a 0.75 gram layer; 9 for a 1.50 gram layer, etc., and was independent of relative humidity conditions.

These values apply only to acetic acid vapor which has a diffusion constant of 0.11 cm²/sec at room temperature and pressure (Sherwood, 1937). For other odors, the reduction factors probably would be not much different, since most gaseous odors have diffusion constants between 0.04 and 0.15 (Sherwood, 1937). Even though the odor reduction factor varies somewhat for different odors, these differences tend to cancel out when comparing two different refrigerators.

In order to assign a number to the odor intensity, the threshold unit concept (Hopper, 1959) was used. For example, an odor having five times the concentration of odor molecules necessary to be just detectable is said to have an odor level intensity of five threshold units.

Activated charcoal tubes used in this work caused odor reduction by factor of 243, 81, 27, 9 and 3. For the tube having a reduction factor of 9, the odor molecule concentration in the influent is 9 times the odor concentration in the effluent, etc. Hence, in a refrigerator test, if panelists found that the air stream from this tube had a threshold odor, the odor level in the refrigerator was 9 threshold units. In comparing refrigerator odors, results are reported in terms of odor intensity ratios or ratios of threshold units in the refrigerator without charcoal to threshold units in the refrigerator with charcoal.

Odor level intensity was also evaluated using an objective method, reduction of potassium permanganate. Since many food products, and especially those which are generally agreed to have strong food odors, contain substances volatile at ambient temperatures which are able to reduce alkaline permanganate solutions, the concentration of these volatile reducing substances (VRS) was measured. The measures had been previously correlated to organoleptic evaluations (Farber, 1957). Air from refrigerators under test was bubbled through alkaline 0.001 N potassium permanganate for one hour. Reduction of the permanganate was measured by light transmission through the solution in a Klett-Summerson colorimeter using a green filter.

Odor transfer was measured by groups of trained panelists sniffing various food materials placed in sealed refrigerators with odorous foods, doors being opened and food load removed and replaced at intervals to simulate household use. Two groups of panelists were selected from volunteers on the basis of their acuity for onion odor. Odor intensity differences were measured using the triangle test (Peryam, 1958).

Two odor receiver food samples from the control refrigerator and one from the activated charcoal equipped unit or vice-versa, were smelled in succession, and the panelist was asked to select the odd sample and state whether it had more or less odor than the other sample. The correct triangle selection could be made in three times by chance, and the correct intensity judgment would arise by chance once in six tries. Thus, a result showing 16.7% correct intensity judgment could be considered as arising by chance. Significance of results was determined by a standard statistical chi-square technique (Guilford, 1954).

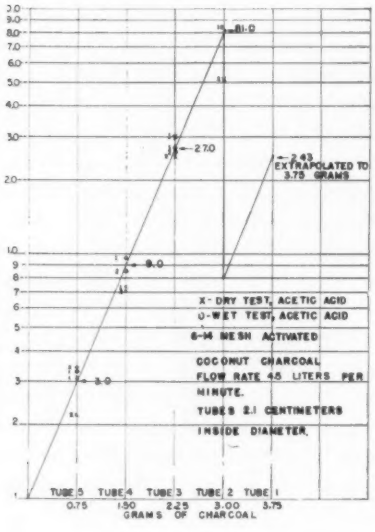


Fig. 1 Relationship between charcoal bed thickness and odor reduction factor

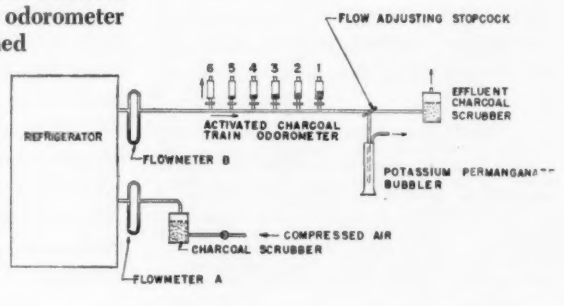


Fig. 2 Refrigerator with charcoal train odorometer attached

TABLE I

REDUCTION OF REFRIGERATOR ODOR BY ACTIVATED CHARCOAL, ODOROMETER TEST

Odor Produced By	Odor Intensity Ratio* A	B	C	D
400 ml onion juice	40			
200 ml onion juice	13		2.4	6.1
100 ml onion juice		5.8	3.2	
200 ml garlic juice	24	3.0		
100 ml garlic juice			3.0	
400 g onion slices	17			
300 g onion slices	4.9			
200 g onion slices	3.4		4.2	
7 oz limburger cheese	11			
200 ml cider vinegar	7.3			
200 ml wine vinegar	4.1			
200 ml cider-tarragon vinegar	5.5			
1 lb fish	31			
Chemical fish odor (TMA)	13			

* Ratio of odor intensity in refrigerator without activated charcoal to odor in refrigerator with activated charcoal.

A. Air circulating fan on, 2 charcoal canisters in series in air duct from fan.
B. Air circulating fan off, 2 charcoal canisters placed on refrigerator shelf.
C. Air circulating fan on, 2 charcoal canisters placed on refrigerator shelf.
D. Air circulating fan on, 1 charcoal canister placed in air duct from fan.

TABLE II

REDUCTION OF REFRIGERATOR ODOR BY ACTIVATED CHARCOAL, VRS TEST*

Odor Produced By	Odor Intensity Ratio** A	B	C	D
400 ml onion juice	1.5			
200 ml onion juice	4.2	1.2		10
100 ml onion juice		1.3	1.3	
200 ml garlic juice	3.7	1.2		
100 ml garlic juice			none	
400 g onion slices	3.1	3.5	none	
300 g onion slices	1.8			
200 g onion slices			1.8	
7 oz limburger cheese	2.9	1.3	none	
200 ml cider vinegar	8.3			
200 ml wine vinegar	complete			
200 ml cider-tarragon vinegar		1.2		
1 lb fish	4.8			
Chemical fish odor—0.05 % TMA***	complete			
Chemical fish odor—0.1 % TMA	complete			

* Measurement of volatile reducing substance with $KMnO_4$.
** Ratio of odor intensity in refrigerator without activated charcoal to odor intensity in refrigerator with activated charcoal.
*** Trimethyl amine.

A. Air circulating fan on, 2 charcoal canisters in series in air duct from fan.
B. Air circulating fan off, 2 charcoal canisters placed on refrigerator shelf.
C. Air circulating fan on, 2 charcoal canisters placed on refrigerator shelf.
D. Air circulating fan on, 1 charcoal canister placed in air duct from fan.

TEST PROCEDURE

Two identical 12 cu ft production domestic refrigerators were selected for the test, each equipped with a circulating fan, which delivered about 22 cfm through the installed ductwork. Screen wire canisters 1.75 x 6.00, 0.875 in. in direction of air flow, were used to contain the activated charcoal. Installation of these canisters in the ductwork naturally caused a reduction in the air volume delivered, to about 9 cfm with one canister in the ductwork, and to about 5 cfm with two canisters installed in series. Each canister contained about 70 grams of charcoal. The one pass efficiency of a single canister was estimated to be over 90% at a flow rate of 9 cfm.

In most of the tests two canisters in series were used. The canister or canisters were placed in one refrigerator only. The other refrigerator had none, and served as a control. Granular 6 x 14 mesh activated coconut shell charcoal, 50 minute test, was selected for trial because it was recommended as the best material available for odor adsorption (Barneby, 1957). Refrigerator cabinets were sealed so that gas leakage was insignificant for odor testing purposes. The roles of the refrigerators were reversed periodically to assure that odor build-up was not a contributory factor to results.

Fig. 2 shows one of the refrigerators with charcoal train odorometer attached. Both refrigerators had identical odorometers. Air entered refrigerator continuously at the bottom after purification by passage through an activated charcoal scrubber. In the standby position, the air passed through the effluent charcoal scrubber. When a panelist was available for test, the stopcock below the first tube was opened for a few seconds, and a panelist sniffed the emerging air. If no odor was detected, the stopcock was closed, and stopcock under the second tube opened for a determination on the second tube, proceeding until an odor was detected from one of the tubes. When desired, the effluent was switched to the potassium permanganate bubbler for chemical determinations. Two flowmeters were used so that if leaks were present they were detected. For example, if flowmeter B read consistently

TABLE III

DECREASE OF ODOR INTO WATER IN REFRIGERATOR WITH USE OF ACTIVATED CHARCOAL

Odor Produced By	Percentage of Judgment Indicating Decrease of Odor Transfer A	B	C	D
200 ml onion juice	80	56		94
100 ml onion juice		94	53	
200 ml garlic juice	90	41		
100 ml garlic juice			44	
400 g onion slices	95		13	
300 g onion slices	67			
200 g onion slices	56		80	
7 oz limburger cheese		29	47	
200 ml cider vinegar	100			
200 ml cider-tarragon vinegar		67		
1 lb fish	90			
Total Percentage	87	57	46	94
Total Judgments	(178)	(65)	(61)	(17)

A. Air circulating fan on, 2 charcoal canisters in series in air duct from fan.
B. Air circulating fan off, 2 charcoal canisters placed on refrigerator shelf.
C. Air circulating fan on, 2 charcoal canisters placed on refrigerator shelf.
D. Air circulating fan on, 1 charcoal canister placed in air duct from fan.

TABLE IV

DECREASE OF ODOR TRANSFER INTO VARIOUS FOODS IN REFRIGERATOR WITH USE OF ACTIVATED CHARCOAL

Odor Produced By	Percentage of Judgments Indicating Decrease of Odor Transfer				
	Water	Whole Milk	Skim Milk	Butter in Open	Butter in Butter Keeper
200 g sliced onion	71	94	67	72	
30 g chopped garlic	64	82		50	
1 lb fish	47		60	49	41
Chemical fish odor (TMA)*	89				
Sliced apples	56				78
Acetic acid (Glacial)		70		80	
100 ml vinegar				82	81
3½ oz. limburger cheese		90	75	51	38
Total percentage	66	85	69	63	61
Total judgment	(109)	(53)	(39)	(254)	(93)

* Trimethyl amine.

TABLE V

DECREASE OF ODOR TRANSFER INTO VARIOUS FOODS IN REFRIGERATORS UNDER SIMULATED HOUSEHOLD CONDITIONS WITH USE OF ACTIVATED CHARCOAL

Odor Produced By	Percentage of Judgments Indicating Decrease of Odor Transfer				
	Water	Whole Milk	Skim Milk	Butter in Open	Butter in Butter Keeper
200 g sliced onion			70	63	67
100 ml cider vinegar				73	45
200 ml cider vinegar	84				62
3½ oz. limburger cheese		80	80	44	
Grape drink				65	
Total percentage	84	80	75	67	59
Total judgments	(19)	(10)	(20)	(58)	(32)

differently than A, a leak was indicated as present.

Odor intensity reduction: Results of subjective tests, using trained panelists and the odorometer just described, are given in Table I. Four different combinations of activated charcoal quantity and activated charcoal positions were used, as described in the table notations. Performance figures in the table give ratios of odor intensity in the refrigerator without activated charcoal to odor intensity in the refrigerator with activated charcoal.

For example, in the case of 400 ml of onion juice in refrigerators with 140 g of activated charcoal in the air stream, the amount of odor present in the refrigerator without activated charcoal was forty times greater than that present in the unit with the activated charcoal filter. Expressed in another way, only 1/40th of the odor present in the control refrigerator was present in the unit equipped with granular activated coconut shell charcoal. With the filter in the air stream minimum reduction was a factor of 3.4. In general, less odor reduction was obtained by removing the filter from the air stream, and greater odor reductions were obtained with stronger odors.

Results of odor intensity tests, using the objective potassium permanganate method, are presented in Table II. Again, greater odor reductions were evident in the unit containing activated charcoal in the air stream, and lesser reductions were found with activated charcoal in other positions. Direct correlation between panel and chemical tests could not be found since this volatile reducing substances method (VRS) measures only a fraction, albeit a significant fraction, of total odor present. For purposes of these studies, VRS may be considered an approximate index of gross odor rather than an exact measure of relative odor intensities which could not be obtained since potassium permanganate measures only one odor property, chemical reduction.

Results of odor transfer tests are given in Tables III, IV and V. Table III shows the decrease of odor transfer of given odorous materials into water in sealed refrigerators.

As with refrigerator odor, odor transfer was decreased the greatest amount by activated charcoal in the air stream, and lesser amounts by placement in other positions. In all cases except the 400 g of onion slices in a unit with activated charcoal removed from the air stream, the probability of any of the results arising by chance alone was less than one in one thousand. Total percentage of correct judgments was so high for each activated charcoal variation that decrease of odor transfer was conclusive.

Table IV shows results of a series of odor transfer tests run in paired closed conventional (unsealed) domestic refrigerators. One was used as a control and the other had an activated charcoal filter weighing approximately 100 g placed over one of the air circulating system's outlet ducts.

The remaining outlet ducts in both units were sealed so that all of the air in the control unit would take a similar path. Results in Table IV are expressed as percentage correct judgments with 16.7% correct being the base which could arise by chance alone. In every case, results were highly significant, indicating decrease in transfer of odors to the designated receivers.

Table V indicates results obtained using the same equipment and techniques used to obtain data of Table IV except that the refrigerators were operated under simulated household conditions with door openings and dummy food loads. Results were highly significant in favor of activated charcoal as a means of decreasing odor transfer.

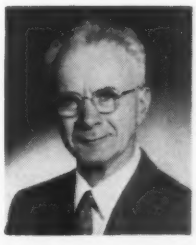
CONCLUSIONS

Granular activated coconut shell charcoal, used under both extreme and simulated household conditions, significantly reduced refrigerator odor and odor transfer between foods. Most efficient odor decreases were found when activated charcoal was placed in the path of forced air used for cooling; activated charcoal out of the path of forced air was less efficient, as was activated charcoal in a cabinet without forced air, but all three are significantly superior in odor removal performance to controls with no adsorbent present.

Highly marketable grapes maintained by

Controlled humidity

K. E. NELSON



RENE GUILLOU

Table grapes are acutely subject to water-loss during storage. The stems will show pronounced shriveling with losses of 3-4 per cent of the weight of the fruit.[4] This condition detracts from the appearance of the fruit and dry brittle stems may break causing shatter. At above 4 per cent loss, softness of the berries starts to become evident which gives the fruit a dull lifeless appearance.

A storage environment of about 32 F and 85-90 per cent relative humidity has been recommended to minimize this rate of water-loss.[1] It has been the experience of most cold storage operators that this level of relative humidity is quite difficult to maintain, particularly during the first 2-3 weeks of the storage season. The work of Pentzer[5] would indicate that this difficulty may be due in part to the absorptive capacity of the containers for moisture. They found that the containers gain weight in storage and that the amount of this gain increases with relative humidity.

Grapes develop a vapor pressure quite close to that of pure water. Ghane[2] found that it was necessary to raise the relative humidity to more than 97.5 per cent at room temperature to stop weight-loss of Emperor grapes. Clearly, the moisture absorbed by the containers must come from the fruit unless water is added to the system in some other way.

It has been claimed frequently by storage operators that the stems of grapes stored in lugs with curtains remain fresh and plump longer than do those of fruit stored without curtains. It has been shown that the rate of air movement is correlated with the rate of moisture loss from fruit at low velocities.[6] Presumably then, any barrier which affects air velocity, such as curtains and container walls, would be a factor in determining the rate of weight loss of the fruit.

The purposes of this study were to investigate: 1. Rate and amount of moisture gained by grape containers with different types of sides, with and without curtains, at three relative humidities when held at storage temperatures. 2. Rate and amount of moisture lost from stored grapes under the same conditions. 3. Effect of these variables on stem dryness and berry decay. 4. Engineering aspects of humidity control.

EXPERIMENTAL PROCEDURE

Mature Emperor grapes were harvested October 20 at Davis, Calif., trimmed, placed in field lugs, precooled to 40 F within 6 hr and held at 36 F and 85 per cent relative humidity. On November 5 the fruit was packed in dry, wooden, 28-lb lugs with four types of sides:

(1) Full, 5¾ in. wide, extending from bottom to cover.
(2) Standard, 5 in. wide, leaving ⅜ in. cracks at bottom and cover.
(3) Slatted, two 2-in. strips.
(4) Cameo, tapered at bottom.

Half of the lugs with liners and half of those with curtains had baskets of ¼-in. mesh hardware cloth which fitted tightly inside of the lug so that the fruit could be lifted from the lug periodically for weighing without disturbing the packed clusters.

After the gross weight of the

Here is a report upon a study on the significance and control of relative humidity in the storage of table grapes which shows that—

Grapes in 34 F storage lost weight at about a constant rate for a 160-day storage period

Total loss ranged from 1 to 7 per cent

Containers gained from 14 to 20 per cent in tare weight

Decay was greater at higher humidities

Humidity may be raised to any desired level by fog-spray

Substitution of steam for spray is shown to impose a serious additional refrigeration load.

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packed lugs had been determined a third of the fruit was placed at each of 3 relative humidities – 85, 90 and 95 per cent plus or minus 1 per cent. The temperature of all of the chambers was held at 34 F plus or minus 2 F. Air movement past the containers varied from 20 to 50 fpm.

The relative humidity was held constant by means of a calcium chloride solution into which an excelsior drum dipped as it rotated slowly. The vapor pressure of the air was brought into equilibrium with that of the salt solution as the air was forced through the excelsior by a fan. The concentration of the salt solution was kept constant, by adding either salt or water, depending upon whether the solution lost or gained water from the system. Dry-bulb and dew-point temperatures were recorded with a recorder from resistance thermometer and sensing elements.

The fruit of each chamber was fumigated weekly by the addition of sulfur dioxide gas to equal ¼ per cent of the volume of air in the empty chamber, followed by purging with fresh air after 30 min. After four months it appeared that the fruit stored at 95 per cent relative humidity had decayed more than that held at 90 and 85 per cent. Although each chamber received the same dosage of sulfur dioxide, the actual concentration of the gas in the chamber during the entire fumigation period was measured to see if the fruit of all three chambers was exposed to the same concentration of the fumigant. These measurements were made with an infra-red compound gas analyzer using techniques described earlier.[3]

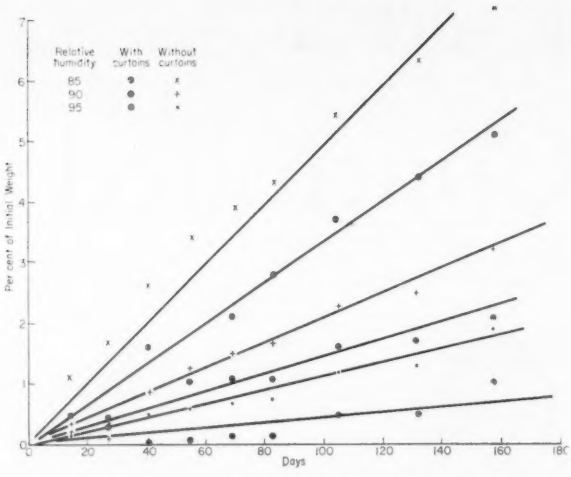


Fig. 1 Linear relationship between weight loss of grapes against storage time

Fruit in the wire baskets and the containers was weighed separately every two weeks during the first three months of storage and once a month thereafter. The tare, net, and gross weights of the containers with no wire baskets were determined only at the beginning and end of the test. After 160 days of storage final weights of the fruit and containers were recorded. At the same time the fruit was examined for stem dryness and for decay.

IT WAS FOUND THAT–

Weight change of fruit and containers – Plotting weight-loss of grapes against time in storage indicates an approximately linear relationship (Fig. 1). There is some evidence that weight is lost more rapidly for the first 30 to 50 days and more slowly thereafter; however, such differences are of questionable significance.

Rates of weight-loss in various containers are plotted against relative humidity in Fig. 2. Losses are significantly less when curtains are used but there are no consistent differences between different types of containers. The shape and position of the curves suggest small losses at 100 per cent relative humidity – losses possibly due to respiration[2]. Losses would be expected to be about proportional to the vapor-pressure difference between fruit and air, but in this test losses at the greater vapor-pressure differences were faster than this relationship would indicate.

The initial moisture content of the boxes averaged 6 per cent of

Fig. 2 Net weight loss in various containers plotted against relative humidity

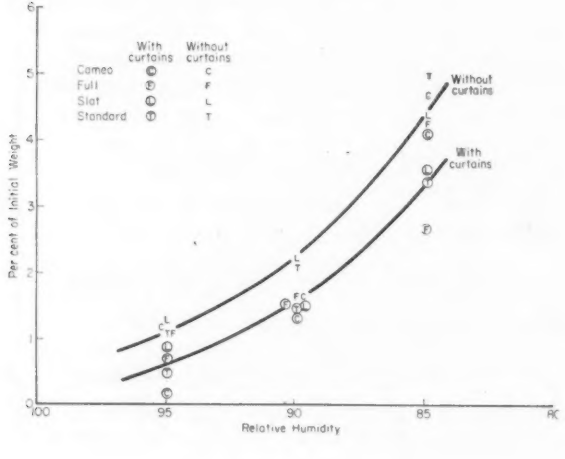
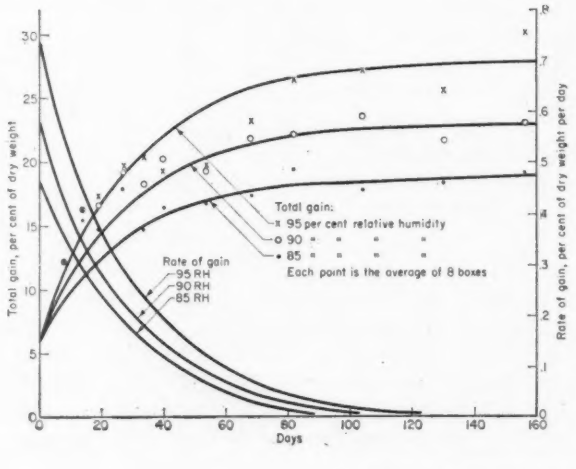


Fig. 3 Tare weight gain of grape containers per day in storage



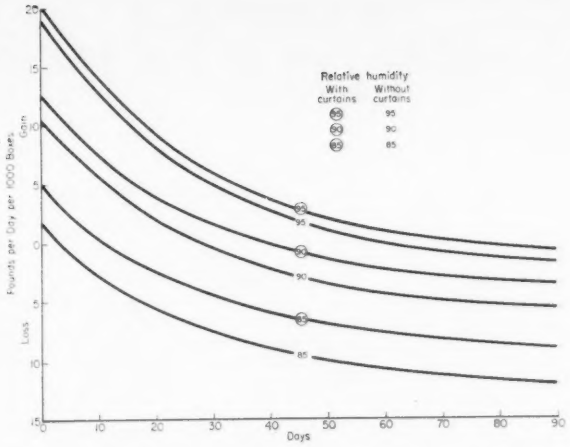


Fig. 4 Gross weight change of grapes and containers per day in storage

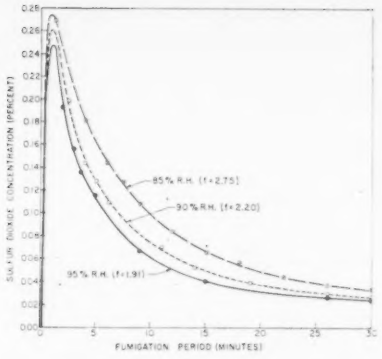


Fig. 5 Fruit stored at higher humidities is exposed to a lower concentration of sulfur dioxide when fumigated

their dry weight, increasing to a maximum of 28 per cent after 156 days at 95 per cent relative humidity. These results agree with accepted figures for equilibrium moisture content of wood. Measured gains were quite erratic, due probably to errors in weighing. Rates of gain might be expected to be about proportional to remaining differences from equilibrium moisture content. The data are in reasonable agreement with logarithmic curves in which both the remaining differences from equilibrium moisture content and the rates of gain are decreased by one-half in each 20-day period, as shown in Fig. 3.

The initial 6 per cent moisture content of the boxes at Davis, corresponding to equilibrium with an effective relative humidity of 30 per cent, is probably representative of western fruit areas. An initial moisture content of 4 per cent under desert conditions or of 10 per cent in a higher humidity would correspondingly increase or decrease the initial rates of gain.

Weight losses by grapes and gains by containers may be combined to show gross weight change (Fig. 4). The common observation that gross weights do not change much in a good storage is apparently to be expected if the relative humidity is initially a little less than 85 per cent and gradually increases to 90 or 95 per cent after 60 days or more. It should be remembered, however, that under these conditions each container will have absorbed almost a pint of water and the grapes inside it will have lost at least an equal amount of water.

Stem dryness—Stem condition was evaluated after 160 days in storage. At this time the stems in all lots were almost completely dried and there was no relation between this condition and either storage humidity or type of container. There was less drying in containers with curtains. Because of the advanced stage of dryness these observations appear to be of limited value and are not reproduced here.

Fruit decay—Amount of decayed fruit in each container was calculated on a percentage-by-weight basis. The averages from the different treatments are shown in Table I. The percentage values were converted by inverse sine transformation for statistical treatment[7].

Neither the type of container side nor curtains had a significant effect on the level of decay. The average of all container-types with curtains at the 90 and 95 per cent relative humidity levels is greater than the average of those without, indicating the strong possibility of a significant difference had there been more replications.

There is a significant difference in the level of decay between the 85 and 95 per cent relative humidity levels for all types of container sides. The 5-in. sided containers showed a significant difference between the 90 and 95 per cent relative humidity levels and only the full-sided container showed a significant difference between all relative humidity levels.

It is quite probable that at least part of the effect of relative humidity on the decay level may be indirect. From Fig. 5 it is evident that the fruit stored at the higher humidities was exposed to a lower concentration of sulfur dioxide each week when fumigated, even though the same dosage was used for all lots. In fact the sulfur dioxide factor (per cent concentration of the gas multiplied by minutes of fumigation) for the 95 per cent relative humidity fruit is slightly over two-thirds that of the 85 per cent fruit. It appears that the moisture content of the containers may have a marked effect on the rate and amount of absorption of the fumigant. If so, the difference in ex-

TABLE I

EFFECT OF CONTAINER SIDE, STORAGE HUMIDITY AND CURTAINS ON DECAY IN EMPEROR GRAPES.

Type of container sides	Per cent of grapes decayed					
	95RH		90RH		85RH	
	Curtain	No curtain	Curtain	No curtain	Curtain	No curtain
Full	17.5	4.6	4.7	1.4	.1	.7
Standard	2.9	3.4	.5	1.1	.0	.3
Slatted	4.3	1.1	1.8	2.2	.0	2.3
Cameo	1.4	1.9	.3	.8	.3	.2
Average	6.5	2.8	1.8	1.4	.1	.9

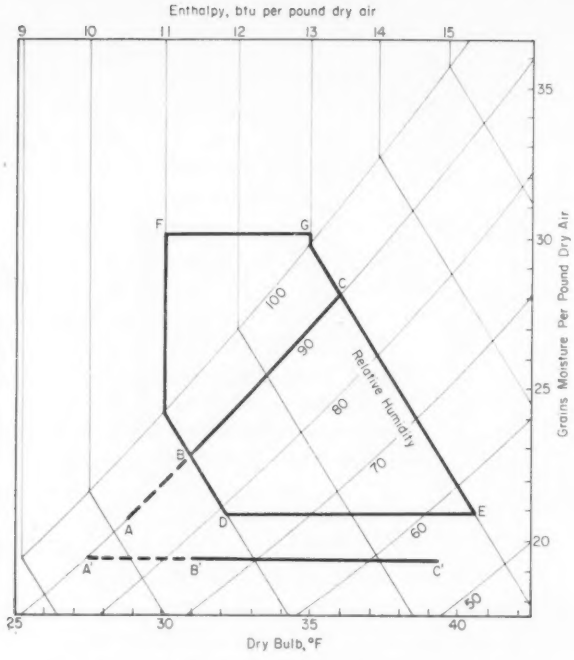


Fig. 6 Effect of adding fog-spray humidification to a typical room with brine-spray cooling

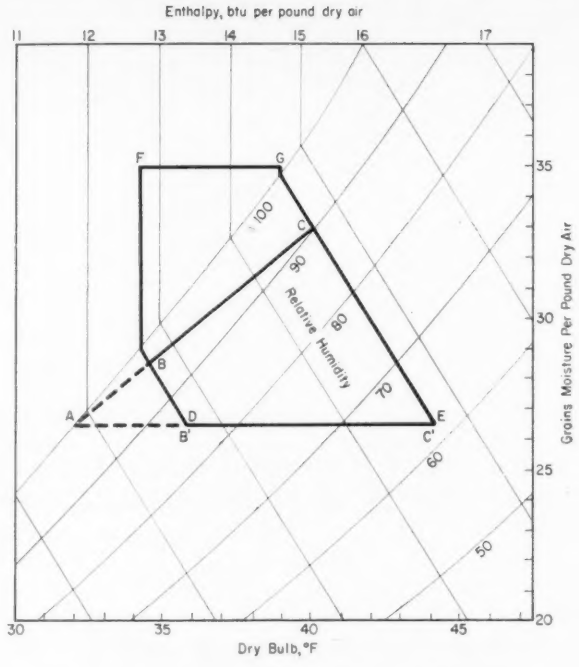


Fig. 7 Condition in a typical cooling room with ice refrigeration, with and without fog humidification

posure between the high and low relative humidity fruit is even greater than the data indicate since the concentrations shown in the figure are in the chamber outside of the fruit containers.

It would be reasonable to expect that as the sulfur dioxide-laden air passes into the container, different absorptive capacities of the container walls would increase the differences in concentration resulting in a greater range of exposure than the figure would indicate. The higher decay in the full-sided containers as compared to the others when held at 90 and 95 per cent relative humidity may be due in a large part to the small amount of sulfur dioxide which actually reached the fruit as a result of restricted air movement, rather than to a higher relative humidity.

It is quite possible that as storage environmental factors are more critically controlled to retard drying of the fruit, fumigation techniques will have to be re-evaluated at the same time, otherwise the benefits derived from these refinements may be nullified by increased amounts of decay.

Engineering considerations in humidity control—It is sometimes assumed that large cooling surfaces operating close to air temperature can satisfactorily control shrinkage of grapes and other fresh products. Even if condensation on the cooling surfaces could be entirely eliminated the product would still lose the moisture absorbed by the containers. In any practicable design the condensation on the cooling surfaces is considerable and this moisture as well as that absorbed by the containers is commonly lost by the fruit. Apparently the only feasible means of maintaining satisfactory humidities with mechanical refrigeration, or even with ice refrigeration when the heat load is heavy, is to add water to the system.

The design of such an arrangement depends on the estimation of the amount of water to be added and the amount of condensation to be expected in the cooling system. This may be done conveniently by diagraming on a psychrometric chart the history of one pound of dry air as it circulates through the system[8]. Fig. 6 illustrates on a psychrometric chart the effect of adding fog-spray humidification to a typical room with brine-spray cooling.

If no moisture is added or removed in the room the air comes to moisture equilibrium with the

TABLE II

COOLING WITH BRINE-SPRAY AND HUMIDIFICATION WITH FOG-SPRAY OR STEAM.

Condition	Humidification Method		
	None	Fog	Steam
Sensible heat load Btu/lb air circulated	2.0	2.0	2.0
By-pass factor	.30	.30	.30
Relative humidity in equilibrium with brine	90	90	90
Brine temperature, F	28	29	27
Air entering room, F	31	31	31
Air leaving room, F	39	36	41
Air entering room, relative humidity	77	91	92
Air leaving room, relative humidity	55	90	90
Fog or steam added, grains/lb air circulated	None	7.2	12.2
Moisture gain by boxes and grapes, grains/lb air circulated	None	2.0	2.0
Moisture condensed in brine, grains/lb air circulated	None	5.2	10.2
Refrigeration load, ton/ton sensible heat load	1.0	1.0	1.9
Fog or steam added, lb/ton-day sensible heat load	None	150	253
Condensation in brine, lb/ton-day sensible heat load	None	108	218

TABLE III

COOLING WITH ICE AND HUMIDIFICATION WITH FOG-SPRAY

Condition	Humidification Method None	Fog
Sensible heat load, Btu/lb air circulated	2.0	2.0
By-pass factor	.30	.30
Air entering room, F	36	34
Air leaving room, F	44	40
Air entering room, relative humidity	86	97
Air leaving room, relative humidity	62	90
Fog added, grains/lb air circulated	None	6.5
Moisture gain by boxes and grapes, grains/lb air circulated	None	2.0
Moisture condensed on ice, grains/lb air circulated	None	4.5
Fog added, lb/ton ice melted	None	134

brine and heat is alternately gained and lost between B′ and C′. With fog-spray humidification the air alternately gains and loses both heat and moisture between B and C. Considering the operations in sequence, net absorption of moisture by containers and fruit is represented by line BD, sensible heat gain in the room is represented by DE, spray humidification by EC, and loss of heat and moisture to the brine by CB. This sequence represents addition of all the spray to the air leaving the room, which results in a low humidity at E before the spray is added.

Adding all the spray to the air entering the room produces the condition at F, with 6 grains of suspended water in each pound of air. For comparison, natural fogs contain up to 2 grains of suspended water per lb of air. Sensible heat gain and evaporation of suspended water is represented by FG and net absorption of water by containers and fruit is represented by GC. Whether this sequence could be carried out without troublesome fall-out of the suspended water is questionable. However, nozzles can presumably be placed to distribute the spray as the air passes through the room and so maintain satisfactory humidity without excessive amounts of suspended water, though this will require experience and judgement on the part of the designer.

A system of humidification with steam may be illustrated by a similar diagram. Fog-spray and steam are compared with no humidification in Table II. Fog-spray not only raises the humidity but also decreases the temperature difference between entering and leaving air and allows the use of slightly warmer brine. Suspended water is practically the same problem with steam as with fog-spray, and the unfavorable effects of latent heat introduced with steam are evident. Under the assumed conditions, the fog added amounts to about ¾ gal of water per hr per ton of refrigeration, which could be provided at small expense. Condensation in the brine is ½ gal per hr per ton of refrigeration and might be troublesome. Formation of ice on dry coils at this rate would add about 5 per cent to the refrigeration load and would require consideration of the defrosting problem.

Conditions in a typical cooling room with ice refrigeration, with and without fog humidification, are shown in Fig. 7 and Table III. It is evident that humidity in the usual ice-cooled room is not likely to be satisfactory when the heat load is at all heavy, and that fog-spray not only raises the humidity and provides the moisture absorbed by the containers but also materially lowers the air temperatures. In this case there is, of course, no problem of brine dilution or defrosting, but distribution of the fog requires the same attention as in a mechanically refrigerated room.

Several fog-spray humidification systems are in use in California fruit and vegetable storages. An improvised, manually-operated installation at Farmers Ice and Cold Storage in Watsonville is reported to have more than repaid its cost in the first year of operation. An extensive system with automatic controls was installed in 1958 for the DiGiorgio Fruit Corporation in its brine-spray refrigerated coolers and storages at DiGiorgio, California. Measurements in the latter plant were in reasonable agreement with the design diagrams proposed above.

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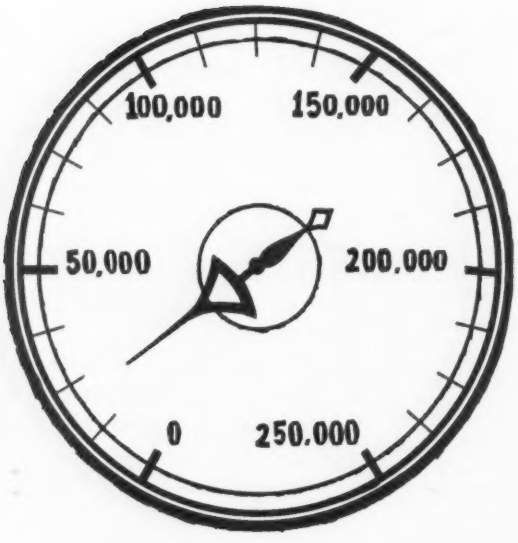

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Is humidity important

in the temperature comfort range?

This condensation of a report at the ASHRAE Semiannual Meeting in Dallas covers results of the research program at the ASHRAE Laboratory to determine the thermal responses of subjects under various environmental conditions after extended occupancy of approximately three hours. The subjects wore normal summer clothing, and were at rest. Air motion in the test room was minimal, and room surfaces were maintained at approximately the dry-bulb temperature. Tests were conducted at dry-bulb temperatures from 68 to 94 F, with relative humidities from 20 to 90%.

The paper shows that the line of optimum comfort is a straight line on a dry- and wet-bulb temperature plane and the effect of relative humidity change is small. Respective points on the optimum comfort line at 77.6 F dry bulb and 30% r.h. and 76.5 at 85% r.h. show that the effect of relative humidity through this 55% range is only 1.1 F.

It should be recognized that increased activity, and impressions felt immediately on entering the room would, of course, show deviations from this. Decrease in weight of winter clothing with the passage of time since the 1920 decade may account for the fact that in winter, at 50% r.h., a 4-F-higher dry-bulb temperature is now desired for optimum comfort whereas there is little change in the summer comfort temperature at this humidity.

WALTER KOCH
B. H. JENNINGS
C. M. HUMPHREYS

The reaction of man to his environment has been a subject of intense interest to the Society for many years. In the decade between 1920 and 1930, the Society carried out work which led to the development of the Comfort Chart. Houghten and Yaglou[1,2] in 1923, combined temperature and humidity into an index of thermal comfort called Effective Temperature (ET). The ASHRAE Comfort Chart for Still Air, shown in the 1959 GUIDE,[3] also indicates the percentages of subjects feeling comfortable in summer and winter. This has served as a widely used standard since its appearance. However, it was felt that additional knowledge on the subject was needed, and in 1956 at the ASHRAE Research Laboratory, construction was started on an environment laboratory in which the needed data could be obtained.

A comprehensive program was planned to carry out studies on the effects of environmental conditions on human comfort, productivity, and learning rate. The first phase of the program, conducted at temperatures considerably above the comfort level, was completed in 1958 and was presented before the Society in January, 1959.[4] The second phase of the study, the results of which are reported in this paper, is concerned with the effects of environmental conditions at or near the comfort level.

It is unfortunate that environmental studies cannot be conducted at a more rapid pace, but working with subject panels is an extremely slow process. Consequently, this paper, as was true of the preceding one, represents a limited contribution to our knowledge of human responses to thermal environment. It applies to individuals under essentially still-air conditions in a uniform environment with the mean radiant temperature maintained close to the dry-bulb temperature. The results are further limited to individuals who have come to equilibrium with the environment after stabilization periods of approximately three hours. Thus, this research covers the responses of subjects to temperature and humidity with the other variables of the environment being so adjusted as to have minimum effect on subjective reactions.

Factors controlling the sensation of comfort – The sensation of comfort in a thermal sense implies the absence of discomfort due to temperature or other atmospheric effects. The average individual will adapt readily to environmental conditions in the comfort range, and this makes the establishment of an optimum line difficult. There is a wide range of temperatures over which an individual will vote "comfortable," and the range for a group of individuals is still wider. Thus, it is obvious that there is no single temperature which elicits the response of "comfortable" from every individual.

The feeling of comfort is also influenced by radiation to or from surroundings, and by the air movement over the body. In this study, the effect of radiant environment has been minimized by keeping room surface temperatures close to the dry-bulb temperature. Nevertheless, radiation is a significant factor and many investigators have considered it. It should be mentioned that the effective temperature scale does not take into account thermal radiation. Vernon[5] applied a radiation correction to effective temperatures by using readings of a globe thermometer instead of the dry-bulb temperatures.

Environment Laboratory and test facility – The entire experimental program reported in this paper was

W. Koch is a Medical Research Supervisor; B. H. Jennings is Director of Research and C. M. Humphreys is Assistant Director of Research, ASHRAE Research Laboratory. This paper, here slightly condensed, was presented as "Environmental Study II. Sensation Responses to Temperature and Humidity Under Still Air Conditions in the Comfort Range" at the ASHRAE Semiannual Meeting in Dallas, Texas, February 1-4, 1960. The complete paper will appear in ASHRAE TRANSACTIONS.

carried out in the Society's Environment Laboratory. A detailed description of this room was included in the preprint of this paper, and will also appear in the TRANSACTIONS.

Participating subjects – Three groups of subjects were used in the project. The first group, which served from September 23 to December 23, 1958 consisted of six high school graduates who were enrolled in evening school. The second group, which varied from six to eight subjects, served from January 5 to March 13, 1959. This group was made up of some of the subjects from the first group and four older subjects. The third group, which worked from June 15 to August 28 consisted of one of the older subjects from Group 2, and seven college students on summer vacation. It was necessary to make a few changes in personnel in each of the groups. Pertinent data regarding the subjects are given in Table I.

TABLE I—GENERAL DATA ON SUBJECTS

Subject Number	Name	Period of Participation	Sex	Age	Height cm	Height Inches	Weight kg	Weight Lbs.	Percentage Deviation*	Date of Metabolism Test
1	CT	9/23/58-11/25/58	F	18	149.9	59	43.50	95.8		
2	JC	9/23/58- 3/13/59	F	18	157.5	62	50.85	112.0	— 1.2	1/ 7/59
3	FB	9/23/58- 1/ 6/59	F	19	165.1	65	60.84	134.0	+ 4.4	1/ 6/59
4	SN	9/23/58-12/19/59	F	18½	164.2	65	50.39	111.0	— 8.4	12/19/58
5	GD	9/23/58- 3/13/59	M	19	173.4	68	60.65	133.6	—12.6	1/ 8/59
6	TR	9/23/58- 3/13/59	M	18	189.6	75	85.62	188.6	—23.4	1/ 9/59
"									—22.8	1/16/59
7	MR	1/19/59- 3/13/59	F	47	163.8	64	49.03	108.0	+ 9.0	1/29/59
8	BE	1/ 5/59- 3/13/59	F	53	153.0	60	53.84	118.6	—16.9	1/15/59
9	WK	1/ 5/59- 3/13/59	F	50	165.1	65	80.49	177.3	— 4.2	1/14/59
10	MJ	1/ 5/59- 3/13/59	F	18	167.6	66	65.74	144.8	+10.9	1/12/59
11	PH	2/16/59- 8/28/59	M	65	160.0	63	55.25	121.7	+ 0.5	2/12/59
"				66			54.84	120.8	— 7.1	9/ 2/59
12	BK	6/15/59- 7/12/59	M	20	173.4	68	62.70	138.1	— 8.3	6/18/59
13	CB	6/15/59- 8/28/59	F	19	164.5	65	55.12	121.4	— 6.5	6/23/59
14	BM	6/15/59- 8/26/59	F	18½	174.0	69	58.52	128.9	— 7.5	6/22/59
"									— 3.5	9/ 8/59
15	BB	6/15/59- 8/21/59	M	19	170.2	67	57.43	126.5	—15.8	6/22/59
16	KP	6/18/59- 8/28/59	F	18	158.8	63	46.76	103.0	—15.6	6/24/59
"							51.03	112.4	— 1.9	8/31/59
17	RC	6/30/59- 7/ 2/59	M	20½	186.7	74	65.78	144.9	— 5.0	6/30/59
18	SJ	7/ 1/59- 8/28/59	F	19½	163.2	64	53.16	117.1	— 6.4	7/ 1/59
"							54.43	119.9	—10.9	8/31/59
19	HD	7/ 9/59- 8/21/59	M	19	172.7	68	62.91	138.6	— 7.4	7/13/59
20	HD	7/20/59- 8/28/59	F	19	168.3	66	56.21	123.8	— 6.3	7/20/59

* Percentage deviation of basal metabolic rate from that predicted on basis of surface area and age

Basal metabolism tests and physical examinations – Each subject underwent a physical examination and, with the exception of Subject No. 1, each was given one or more basal metabolism tests.

Clothing – An investigation of thermal responses of subjects to their environment can more accurately be carried out with subjects in the nude. However, in temperate climates, clothing is always worn both in summer and winter, and it is in connection with clothed subjects that specific data are needed. Consequently, even though clothing presents an additional variable which must be considered, these tests were carried out with clothed subjects. To minimize variation due to clothing, customary indoor summer clothing (men without coats) was specified for both summer and winter, and subjects were asked to wear the same or similar outfits for all tests. The weight of clothing was checked frequently to make certain that this factor remained reasonably constant.

Room arrangement – The subjects were seated on typical college-type classroom chairs, having a wide right-hand arm rest for writing. The chairs were not fastened but could be moved from place to place in the room. However, a fixed position was indicated for each chair.

It was recognized that by increasing the number of subjects in the test room, the reliability of the mean votes could be increased. However, it was essential that the population density be kept low enough that radiation between subjects would not influence their sensation of warmth or comfort. The maximum number of subjects used at any time was 8, and with the observer, this made a maximum of 9 occupants. Thus, in a 12 x 24.5 ft room, 32.7 sq ft of floor area was available per person. Yaglou and Drinker[9] found that with a gross floor area of 25 sq ft per person, no effect of radiation was evident.

Air velocities throughout the occupied zone of the test room were found to be remarkably uniform.

TABLE II—DRY-BULB AND WET-BULB TEMPERATURES EVOKING VOTE "3" FROM EACH PARTICIPANT (F)

Subj. No.	No. of Votes	Mean Dry Bulb	Mean Wet Bulb	Standard Deviation Dry Bulb	Standard Deviation Wet Bulb	Dry Bulb Extremes	Dry Bulb Range	Dry Bulb Overlap Sens. 3 & 4	Dry Bulb Overlap Sens. 3 & 5
1	29	71.26	56.65	1.808	7.768	69.0-75.1	6.1	4.5	0.2
2	42	70.82	56.95	1.095	6.966	69.2-74.0	4.8	4.6	0.0
3	43	73.15	63.10	2.891	7.835	69.2-78.0	8.8	5.7	0.0
4	44	71.42	60.83	2.318	8.366	69.2-76.0	6.8	4.6	0.0
5	39	71.83	59.16	2.607	7.456	69.2-77.2	8.0	8.0	5.2
6	96	74.16	62.45	3.228	7.697	69.1-79.4	10.3	7.9	4.3
7	4	71.95	61.58	1.204	1.208	70.9-74.0	3.1	2.4	0.0
8	14	74.06	61.19	1.086	1.625	72.5-75.5	3.0	3.0	1.0
9	29	73.33	62.51	1.609	2.234	71.0-76.4	5.4	5.0	1.9
10	16	72.43	61.65	2.045	2.315	69.2-75.5	6.3	4.1	0.0
11	34	73.69	63.69	2.470	6.240	70.0-78.0	8.0	5.5	0.0
12	8	71.25	63.95	1.131	2.751	70.0-73.2	3.2	3.0	0.0
13	11	71.68	59.18	2.150	4.298	68.9-74.6	5.7	4.4	0.0
14	23	71.93	60.29	2.399	4.121	68.0-76.1	8.1	3.7	0.0
15	15	71.23	64.46	3.413	4.972	68.0-77.6	9.6	8.7	3.1
16	10	71.64	61.60	1.292	6.412	70.1-74.0	3.9	3.5	0.0
18	12	77.02	63.36	2.608	6.531	73.9-82.0	8.1	8.5	2.0
19	10	71.56	58.79	2.278	7.449	68.9-75.0	6.1	5.0	0.0
20	7	72.84	56.87	2.498	4.008	68.9-76.0	7.1	2.7	0.0

TABLE III—DRY- AND WET-BULB TEMPERATURES EVOKING VOTE "4" FROM EACH PARTICIPANT (F)

Subj. No.	No. of Votes	Mean Dry Bulb	Mean Wet Bulb	Standard Deviation Dry Bulb	Standard Deviation Wet Bulb	Dry Bulb Extremes	Dry Bulb Range	Dry Bulb Overlap Sens. 3 & 4	Dry Bulb Overlap Sens. 3 & 5
1	44	75.62	59.79	2.955	6.981	70.6-80.2	9.6	4.5	5.3
2	139	76.20	63.65	2.322	4.985	69.4-82.5	13.1	4.6	5.5
3	104	78.00	66.33	2.564	5.560	72.3-82.2	9.9	5.7	4.2
4	119	77.76	65.34	2.734	6.550	71.4-82.8	11.4	4.6	3.7
5	120	75.50	62.69	3.023	4.734	69.2-82.8	13.6	8.0	10.8
6	70	76.95	63.10	2.614	5.326	71.5-82.5	11.0	7.9	7.4
7	23	74.97	63.13	1.552	1.083	71.6-77.8	6.2	2.4	0.0
8	38	77.47	63.42	3.339	2.272	72.5-85.0	12.5	3.0	10.5
9	36	76.49	62.65	2.834	1.867	71.4-85.0	13.6	5.0	10.5
10	52	74.86	62.49	2.249	1.800	71.4-80.5	9.1	4.1	3.5
11	30	76.48	62.07	2.966	4.724	72.5-82.0	9.5	5.5	3.4
12	20	76.59	65.29	3.365	6.618	70.2-82.0	11.8	3.0	3.9
13	36	75.08	63.96	2.761	7.865	70.2-80.0	9.8	4.4	4.0
14	54	77.55	64.72	3.676	6.480	72.4-85.5	13.1	3.7	6.7
15	99	78.71	64.45	4.926	6.557	68.9-88.0	19.1	8.7	13.5
16	55	77.04	63.53	3.525	6.111	70.5-83.6	13.1	3.5	9.2
18	29	79.62	66.14	3.783	5.821	73.5-83.9	10.4	8.5	3.9
19	26	75.71	61.82	2.569	4.525	71.0-80.0	9.0	5.0	2.5
20	29	78.24	62.78	3.000	5.113	73.3-82.2	8.9	2.7	1.5

Measurements made with a heated-thermocouple-type anemometer at locations in various places in the room indicated that the velocities at all points were less than 20 ft per min.

Effect of radiation – The importance of radiation on comfort has already been mentioned. It has also been stated that the six room surfaces were held at the same temperature as the room air. However, because of radiation from lights and occupants, the globe thermometer temperature was usually slightly higher than the air temperature. To evaluate the possible effect of this difference between globe and air temperature, a series of tests was conducted with the second group of subjects, in which the room surfaces were maintained at temperatures either above or below the air temperature. These preliminary tests seem to indicate that the effect on human comfort of a 3-degree elevation of room surface temperature over air temperature is approximately equal to the effect of a one degree increase in the dry-bulb temperature. It was therefore decided to maintain air and room surfaces at the same temperature and to neglect minor sources of radiation. This effect was further minimized by excluding data from all tests in which difference between globe and air temperatures exceeded 1.2 F.

TABLE IV—DRY-BULB AND WET-BULB TEMPERATURES EVOKING VOTE "5" FROM EACH PARTICIPANT (F)

Subj. No.	No. of Votes	Mean Dry Bulb	Mean Wet Bulb	Standard Deviation Dry Bulb	Standard Deviation Wet Bulb	Dry Bulb Extremes	Dry Bulb Range	Dry Bulb Overlap Sens. 3 & 5	Dry Bulb Overlap Sens. 4 & 5
1	49	81.30	68.11	2.246	7.083	74.9-85.1	10.2	0.2	5.3
2	65	81.11	67.50	2.844	6.093	77.0-88.0	11.0	0.0	5.5
3	46	81.73	69.41	2.532	7.344	78.0-88.2	10.2	0.0	4.2
4	53	82.43	69.13	3.247	7.301	79.1-88.0	8.9	0.0	3.7
5	108	80.16	68.64	3.978	6.735	72.0-89.3	17.3	5.2	10.8
6	69	81.66	68.57	3.374	5.846	75.1-89.2	14.1	4.3	7.4
7	1	82.00	65.80			82.0-82.0	0.0	0.0	0.0
8	13	80.08	65.02	3.025	2.924	74.5-85.5	11.0	1.0	10.5
9	12	79.26	64.46	2.778	1.597	74.5-84.8	10.3	1.9	10.5
10	14	79.06	64.30	2.057	1.257	77.0-82.2	5.2	0.0	3.5
11	18	81.53	69.12	1.781	5.743	78.6-85.1	6.5	0.0	3.4
12	6	79.87	68.23	1.826	6.672	78.1-82.4	4.3	0.0	3.9
13	29	81.05	67.31	1.950	6.344	76.0-83.9	7.9	0.0	4.0
14	36	85.02	71.49	2.839	6.366	78.8-90.0	11.2	0.0	6.7
15	32	85.78	72.23	3.483	5.599	74.5-91.0	16.5	3.1	13.5
16	36	82.98	68.57	3.017	5.814	74.4-87.6	13.2	0.0	9.2
18	32	83.80	68.79	2.555	5.551	80.0-88.0	8.0	2.0	3.9
19	39	82.86	70.28	3.104	5.284	77.5-90.0	12.5	0.0	2.5
20	21	82.22	71.43	4.648	5.136	80.7-87.0	6.3	0.0	1.5

It should be emphasized that the study of radiation effects was made only to determine an approximate order of magnitude. A more exhaustive study of the subject is contemplated. It should also be pointed out that the results of these tests have not been included in the analysis presented in this paper.

EXPERIMENTAL PROCEDURE

Length of test period – Two test periods were held each working day. The morning period ran from 9 a.m. to 12:15 p.m. and the afternoon period from 1 to 4:15 p.m. The occupants remained in the environment room continuously during each test period and were discouraged from leaving their chairs except at ½ hour intervals when data were taken. They were allowed to read, talk, write, engage in table games, knit or sew as they desired. Smoking was not permitted. In order to assure complete equilibrium, the occupants were exposed to only one dry- and wet-bulb combination in each session.

Sensation scales and voting – Each subject was asked to report his impressions on a number of scales which included thermal sensation, sensation of humidity, sensible perspiration, pleasantness, air motion and sensation of warmth or coolness from surrounding surfaces. Of these, the first four were the most significant, and specific details of these scales are listed below. As previously indicated, the effect of air motion and radiation had been purposely minimized so as to have little effect on the subjects, and they are not reported here. It should be mentioned that each of these scales is arbitrary. A seven-point scale was used for thermal sensations. Both 7-point and 5-point scales have been used by prior investigators and both have been found to be satisfactory.

Thermal Sensation
1. Cold
2. Cool
3. Slightly Cool
4. Comfortable
5. Slightly Warm
6. Warm
7. Hot

Sensible Perspiration
0. Forehead or Body Dry
1. Forehead or Body Clammy (Surface feels moist to touch)
2. Forehead or Body Damp (Perspiration just visible)

3. Forehead or Body Wet
(Sweat covering the surface, frequently in drops)
4. Parts of the Clothing Wet
5. Most, or All of the Clothing Wet

Humidity Sensation
The rooms seems to be
1. Painfully Dry
2. Very Dry
3. Dry
4. Normal
5. Humid
6. Very Humid
7. Wet

Pleasantness
1. Pleasant
2. Indifferent
3. Unpleasant
4. Very Unpleasant

Votes on the above scales were cast by the subjects every half hour throughout each test period. A perusal of the data indicated that the most stable votes were those which were cast toward the end of the session after the subjects had reached a state of thermal equilibrium.

Data and programming – The pulse rate and oral temperature of each subject were recorded at half hour intervals and the weight of the subject was taken at the beginning and end of each session as the study progressed.

Outdoor dry- and wet-bulb temperatures were taken and the weather conditions were noted before each session. In the environmental room itself both dry- and wet-bulb temperatures were taken at half hour intervals, using an aspirated psychrometer with mercury-in-glass thermometers. Wet- and dry-bulb resistance thermometers located in the same air stream were connected to electronic controller-recorders on the main control panel where both temperatures were indicated and recorded. Check readings were also taken frequently with a sling psychrometer. Wall-surface temperatures were determined by means of thermocouples on the surfaces, which were connected to the electronic recording and indicating potentiometers on the control panel. The globe temperature was obtained by reading a mercury thermometer having its bulb at the middle of the globe, or by thermocouples soldered to the globe and connected to the potentiometer.

Data analysis and results—The several sensation votes cast simultaneously by each subject were transferred to a single index card. Also entered on the card were the date, time of day, number of subject, and the dry-bulb, wet-bulb and globe temperatures. Each card was numbered in chronological order for processing.

There are several methods which can be followed in analyzing the votes. For example, the votes cast by each participant can be treated separately and for each sensation the mean dry-bulb and mean wet-bulb temperatures can be found. This method is applied when a comparison between participants is needed.

The analysis of individual votes becomes difficult when a subject is absent from a test and leaves a blank for this test condition. It cannot be predicted what his vote might have been because of the wide overlap in air temperatures between sensations. Consequently, to minimize the effect of missing votes, it was decided to analyze the data on the basis of mean votes obtained by averaging all votes cast simultaneously.

A complete tabulation of individual votes would require excessive space, and a condensation of them has therefore been presented in Tables II, III and IV. Table II gives the mean dry-bulb and mean wet-bulb temperatures which evoked the sensation—"slightly cool" (3), and their standard deviations. The highest and lowest dry-bulb temperatures (dry-bulb extremes) at which "3" was voted, the difference between the extremes (dry-bulb range), and the temperature overlap of sensations are also given. Tables III and IV give similar information on sensations "comfortable" (4) and "slightly warm" (5).

It should be kept in mind that the number which was assigned to each thermal sensation is not a true number but a rank. Objection therefore could be raised to treating these ranks like ordinary numbers, to forming their mean, and to reassigning to this mean a position on the rank scale. It was found, however, that within the comfort range, ranks may be treated like numbers without an appreciable error. Caution is, however, indicated near either end of the scale.

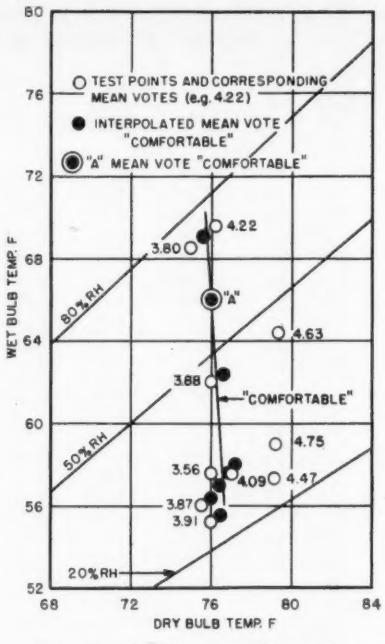

Fig. 1 Method employed in locating sensation line by interpolation

Sensation "cold" (1) and "hot" (7) may be considered collective votes in the sense that whatever the degree of cold or heat, a person cannot vote lower than 1 or higher than 7. This does not mean that it is impossible to find lines of equal thermal sensation in the hot or cold regions.

When simultaneous votes are averaged, the mean vote is not likely to be an integer. However, it is possible to interpolate between such mean votes to determine the location of the integer vote lying between them. The premises for linear interpolation are equidistant spacing of the thermal sensation lines on the dry- and wet-bulb scales, and the absence of differences in curvature. Although neither of these was strictly true, cross checking indicated that no serious error was caused by this approach if the interpolations were made over small intervals. This method of interpolation has been successfully used by T. Bedford[11] and R. G. Nevins.[12]

Fitting of interpolated points by straight lines – With the lower thermal sensations ("3" and "4") an approximately linear course soon was apparent. Linear regression lines were fitted by calculating the coefficient of correlation (r) as well as the coefficients of regression,

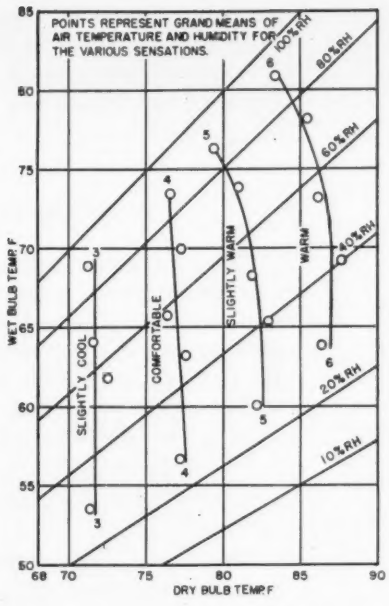

Fig. 2 Lines of equal thermal sensations

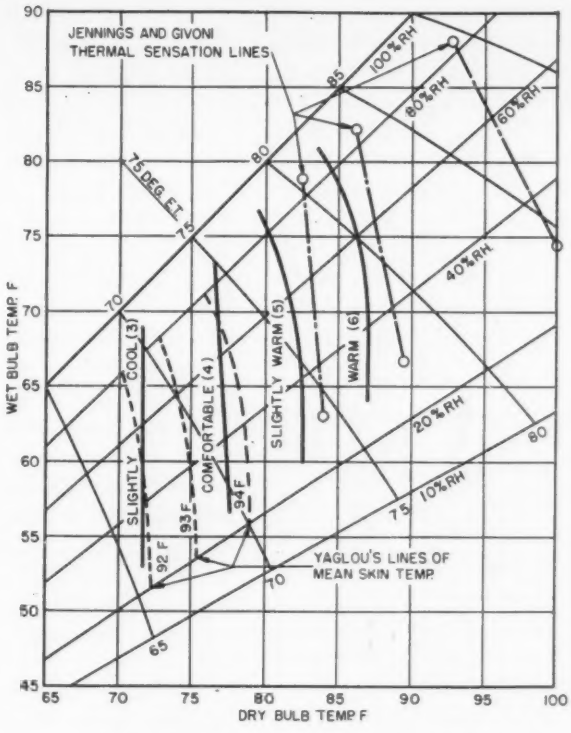

Fig. 3 Comparison of new data with results of former investigators

$\frac{\sigma_y}{\sigma_x}$, and $\frac{\sigma_x}{\sigma_y}$, in which σ_x is the standard deviation of dry-bulb temperatures and σ_y the standard deviation of wet-bulb temperatures. The two regression lines intersect at a point whose ordinates are the mean dry-bulb and the mean wet-bulb temperatures. The angles which the regression lines make to the horizontal and vertical respectively are measured by the coefficients of regression. Both regression lines are not always of equal standing, and one may have a definite physical meaning, while the other has only conventional meaning given to it by mathematical definition.[13] Of the two regression lines which were calculated, the one showing the mean values of dry-bulb for regularly increasing values of wet-bulb was used. The slope of this line refers to its angle with the vertical; by subtracting this angle from 90, the more customary form of measuring angles, namely starting counterclockwise from the horizontal, was adopted.

Fig. 1 has been prepared to illustrate the method of data analysis. The circles on the figure show the various environmental conditions for a short series of tests, and the adjacent figures are the mean votes of the groups at these conditions. The dot noted A is a mean vote which happened to be 4.0. All other dots represent the location of "4" votes which have been determined by linear interpolation between two circles with which they are in line.

The regression lines were calculated as indicated above from the dry-bulb and wet-bulb coordinates of the dots, and the relevant regression line is shown. This is the straight line of best fit for the plotted data. It should be pointed out that this example was worked out for a relatively small number of tests, and the results therefore differ somewhat from those found for the complete study.

Though curvature was evident for sensations "5" and "6," coefficients of correlation and regression coefficients were also calculated, though the latter served only as indicators of direction.

As indicated earlier, test points were chosen to provide a distribution of data along selected relative humidity lines. At the completion of the test program a great number of individual votes were available along each of these lines. This mass of data was reduced by three successive steps. First the individual votes were converted to group means. Next, from the group means, integer votes of sensations "3", "4", "5", and "6" were determined by interpolation as described above. Grand means were then determined by averaging the temperature and humidity coordinates of each group of integer votes at the four or five humidity levels, and the points are shown in Fig. 2.

Sensation lines "3" and "4" on Fig. 2 are the relevant regression lines for the points shown. It should be pointed out that the line of optimum comfort is based on both winter and summer data. Separate treatment of the winter and summer data indicated a difference of approximately 1.2 degrees ($P = 0.0057$) in the mean dry-bulb temperatures for the two seasons. Thus, the winter comfort line would be 0.6 F lower, and the summer line 0.6 F higher than the mean comfort line that is shown in Figs. 2 and 3.

Thermal sensations "5" and "6" depended on humidity as well as air temperature, and the plotted points could be fitted only by curves. The following polynominal equations were derived and were used as an aid in plotting curves for sensations "5" and "6".

For Sensation "5":

$$t_a = 20.22 + 1.983\, t_w - 0.01576\, t_w^2$$

For Sensation "6":

$$t_a = -29.20 + 3.384\, t_w - 0.02459\, t_w^2$$

Where t_a and t_w are the dry-bulb and wet-bulb temperatures F, respectively.

Fig. 3 presents a comparison of the results of the present study with the findings of other investigators. The thermal sensation lines "3", "4", "5" and "6" developed in this study are shown solid. Also shown are the original effective temperature lines developed by Houghten and Yaglou,[1,2] the lines of mean skin temperature as established by Yaglou,[14] and the thermal sensation lines of Jennings and Givoni.[4]

Discussion of results – From Fig. 3, it is immediately apparent that the slope of the new sensation "4" line and the effective temperature lines differ appreciably. A critical comparison is therefore indicated.

It may be seen that along the line of optimum comfort (sensation "4"), a change from 20 to 80% relative humidity is compensated by a drop of approximately 1.5 F in dry-bulb temperature. A similar change in relative humidity along the 68 F ET winter comfort line or the 71 F ET summer comfort line would require a change of approximately 6.5 or 7.7 F, respectively, in dry-bulb temperature.

In considering this lack of agreement, one important difference in conditions of occupancy must be recognized. As previously stated, the new work is based on the appraisal of the environment after approximately three-hour occupancy. However, the effective temperature index was established on instantaneous judgments of subjects as they moved from one psychrometric chamber to the other. The chambers were held at different combinations of dry-bulb and wet-bulb temperatures, and were adjusted to provide an equal, or nearly equal, feeling of warmth. Thus, the findings were based on a quick comparison of the rooms with the reaction of the subjects being stated as the same, warmer, or cooler. Dr. E. V. Hill,[1] in discussing the paper, commented that the curves obtained were lines of immediate temperature perception and not equal comfort lines.

A number of previous investigators have felt that the effective temperature lines overestimated the effect of relative humidity. C. P. Yaglou,[15] who was one of the authors of the original paper, stated in 1954, that in his opinion the influence of relative humidity was only about half of that indicated by the original work. He suggested that this overestimation can now be explained largely by the phenomena of adsorption and desorption of moisture on the exposed skin and clothing.[16] Professor Yaglou[14] also proposed that the correct slope of the effective temperature lines in the comfort zone could be established from the lines of equal mean skin temperature of the clothed body. His lines of 92 F, 93 F and 94 F skin temperature, which are shown in Fig. 3, are in much closer agreement with the new thermal sensation lines than are the effective temperature lines. However, it is not generally agreed that skin temperature is an unequivocal measure of thermal comfort.

The results of earlier work by Jennings and Givoni[4] at elevated temperatures are also plotted on Fig. 3. Although the numerical ranks assigned to similar environments by the two groups of subjects varied considerably, the lines of equal thermal sensation as found in the two studies have approximately the same slope. Since the Jennings and Givoni tests were made at only two relative humidities, only two points can be plotted for each sensation line, and these two points have been connected by straight lines.

The experiences of engineers in the field also indicate that comfort is dependent primarily on the dry-bulb temperature, and is so little dependent on humidity that this factor is frequently not even mentioned. Field experience also confirms the fact that comfort is attained at essentially the same dry-bulb temperature, both in winter and summer. W. L. Fleisher,[15] L. T. Avery[17] and C. S. Leopold[18] are among those who have reported their observations on this subject.

Fig. 1 in the recent paper by Werden, Fahnestock and Galbraith[19] shows that a comfort vote of "4" was obtained by their subject panels at 76 F dry-bulb temperatures and 40% r.h., and at 75 F dry-bulb and 80% relative humidity. These two points would set the slope of their "4," or comfort line, at exactly the same angle as found in the studies reported here. Their line is not drawn on Fig. 3 of this paper because copy of their work was not available until after the graphs of this paper had been finished.

CONCLUSIONS

1. Lines of equal thermal sensations for continued occupancy have been determined which are applicable to sedentary (inactive) individuals, lightly clothed in still-air conditions, in a uniform radiant environment with the temperature of the surroundings maintained approximately equal to the air temperature.
2. The line of optimum comfort for both winter and summer is approximately straight and ranges from 77.6 F at 30% relative humidity to 76.5 F at 85% relative humidity. It is only slightly dependent on humidity.

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What we learned about

Water hammer

CARL W. SIGNOR
Member
ASHRAE

As an operator of an extensive steam distribution system, Detroit Edison found that water hammer could become a difficult problem under certain repetitive conditions. All of which called for study and remedial measures. Author Signor explores the findings and developed cures herewith.

Any shock that occurs in piping or a pressure vessel and is associated with the presence or flow of a liquid can be defined as "water hammer." We had a problem that related to the shock that was encountered in steam piping when both condensate and steam were present and the temperature of the condensate was lower than the temperature of the steam.

Water hammer in an underground steam distribution system is most likely to occur when there is flooding of the manholes and underground steam mains. Flooding, in our distribution system, may take place when there is a rainfall of one inch an hour or more near our system or when a break occurs in a nearby water main. The flooding due to a water main break will be confined to a relatively small area whereas a heavy summer rain storm can be more extensive.

The cold water coming in contact with the steam mains produces excessive condensation. When this condensate is cooled below the steam temperature, water hammer may occur.

The Detroit Edison Company operates the second largest steam distribution system in the world. This system conveys the steam from four steam generating plants and supplies nearly all of the large buildings in a downtown area. Our customers use the steam for space heating, space cooling, and for process operations of various types.

There are 52½ miles of underground steam main and 15,000 ft of steam tunnel in the distribution system. Some of the piping has been in service since 1904. Several forms of underground construction have been used over the years, from a pipe insulated with wood-log insulation to the two methods of construction we are using today. The steel arch construction

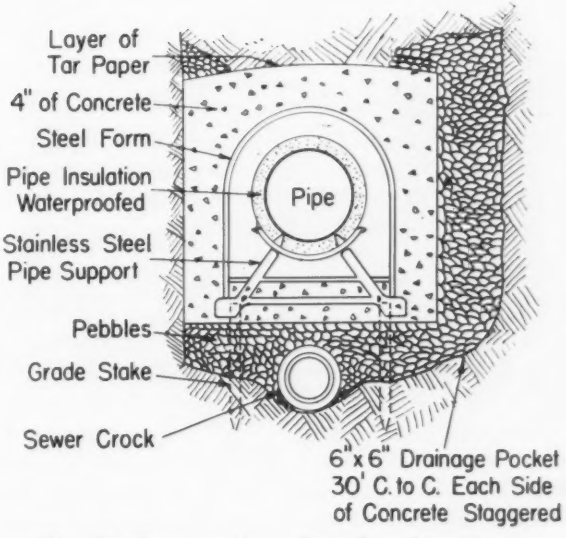
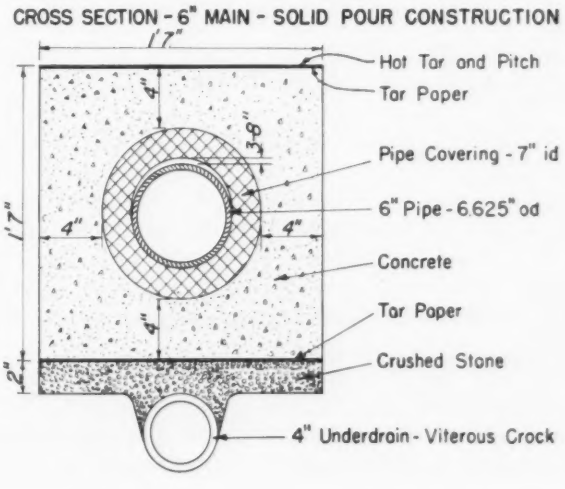


Fig. 1 Cross section of steel arch construction with insulating space

Fig. 2 Cross section of solid pour construction



Carl W. Signor is Staff Engineer, Central Heating Department, Detroit Edison Company. Collaborating with the author were Arnold Featham, Research Department and Ernest T. Smith, then with the Central Heating Department.

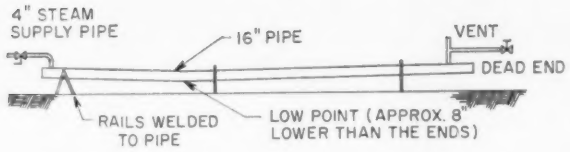


Fig. 3 Plan of water hammer test setup using 60 ft of 16-in. pipe

(Fig. 1) has an insulating air space between the covering and the steel arch. This is a good type of construction, when used where flooding will not occur, as water can traverse the air space.

In the solid pour construction (Fig. 2) thicker insulation is used in lieu of the insulating air space. This construction is used where flooding may occur because if the manholes are flooded the water cannot traverse the underground piping.

The drain tiles shown in Figs. 1 and 2 and the manhole drainage lead to the city sewer system. Excessive rain in or near our distribution system will produce sufficient pressure in the sewer system so that it will back up via the drainage tile and flood our manholes and such construction that has the insulating air space.

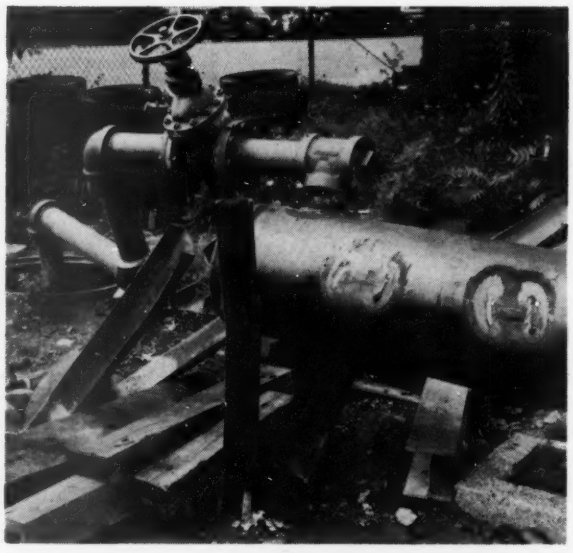
Back in 1932 our distribution system was damaged by water hammer caused by the flooding from a ruptured water main. This prompted us to try to produce a water hammer in some piping set up for test purposes. It was nearly impossible at the time for us to find an arrangement of piping and to duplicate conditions that would produce a water hammer for study. In 1947 after another water hammer experience in the distribution system, we made a test setup duplicating the pipe arrangement in which the water hammer occurred (Fig. 3) using 16-in. pipe. In this piping arrangement we could produce water hammer at any time we desired. In the first test made, the force from the water hammer ruptured the end of the 16-in. main and tore the main loose from the anchors. Figs. 4 and 5 show the damage resulting from the first test.

The test main was repaired and more solidly anchored. A flanged joint designed to hold a rupture diaphragm was installed on the far end of the test main. The diaphragms could be obtained, made of various different metals, to rupture at any desired pressure. For most of the test a diaphragm designed to burst at 300 psig was used. In this way we could prevent further damage to the test piping.

After finding that a water hammer could be produced successfully, a scale model of the test main was built using 2-in. diam pyrex glass tubing. The water hammer could be produced in the glass tubing but the tubing itself was easily damaged. By adding a dye to color the water we were able to make moving pictures of the actual water hammer. In the pictures using the normal 32 frames per sec the movement was too rapid for effective study.

The frames per sec were increased until the desired slow-motion pictures were obtained. Fig. 6 shows the actual movement of the steam and water taken from seven successive frames of the film. The

Fig. 4 Water hammer damage to inlet end of test main



film speed was 480 frames per sec. The steam photographs white and the water, due to the dye, is dark. The steam from a 35 psig source enters the right side of the glass tube and both the bubbles of steam and the water are moving from right to left. The bubble on the left, being in contact with water at a lower temperature, is rapidly condensing. In the last frame this bubble has all but disappeared. The energy of motion in the column of water, following the bubble of steam that condensed, is dissipated in the shock called water hammer.

The pictures from the glass model enabled us to visualize what was happening in the 16-in. test main. When starting a test cold water was piped into the test main until the water at the low point was 9 in. from the top of the pipe. The steam valve at the left end (Fig. 3) was opened allowing steam from a 35 psig source to enter the main.

As the steam entered, the air was vented from the opposite end through a partially opened valve. As more air was vented more steam came in contact with the cold water. The rapid condensation of the steam in the cold water increased the velocity of the steam over the surface of the water. This in turn would start a wave action on the surface of the water. The height of the waves would increase until they would touch the top of the pipe. At this point they would move rapidly to the right due to the steam pressure on one side and the rapidly condensing steam on the other side.

This, in effect, is a thermal pump as it will carry the water into the high end of the pipe completely filling the high end except for the large bubbles of steam trapped by the waves. These bubbles will disappear almost instantaneously due to the rapid condensation. Where this occurs before the bubble reaches the end of the test main (Fig. 7A) it is moving two columns of water, one on each side of the bubble in opposite directions. This will cause shock

but much of the energy is used as turbulence in the water. When the trapped bubble (Fig. 7B) reaches the dead end before the rapid condensation occurs, then only one column of water is moving and in the direction of the dead end. Nearly all of the energy of motion is received by the end of the main as a water hammer.

A pressure transducer was installed on the end of the 16-in. test main opposite the end where the steam entered. The pressure would mechanically stress the resistance wiring in the transducer. The resistance changes were picked up on an oscillograph. This gave indication of pressure surges between 6,000 and 7,000 psi. The surges last for less than one half millisec or 0.0005 sec.

Electrodes were installed to measure the velocity of the wave. The average velocity of a wave as it traveled between one electrode 30 ft from the end and another 6 ft from the end was 50 fps. This is at the end opposite the steam inlet.

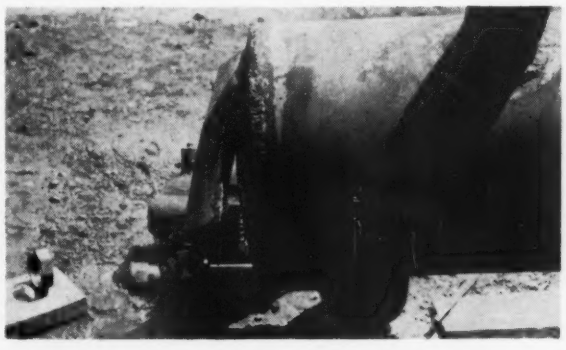


Fig. 5 Water hammer damage at dead end of test main

In both the 16-in. main and the glass model the most severe shocks occurred when the air was completely vented. If the first few shocks did not break the rupture diaphragm on the 16-in. main or the glass on the scale model, the intensity of the shock would subside as the water temperature rose due to the condensed steam.

CONCLUSIONS

The following are observations gained by the foregoing tests and our experience with an underground steam distribution system.

If the condensate can be removed as fast as it is forming, there is no danger from water hammer. We have increased the capacity of the steam traps on the distribution system by installing larger valve seats. We were able to treble the capacity in this way as the traps were originally selected for a higher maximum pressure than carried on the distribution system.

It is important to have steam pressure at all times so that the trap capacity will not be reduced by low pressure should flooding occur. When heavy rain storms are predicted we have additional boiler capacity available to maintain system pressure.

The water hammer described herein can only occur when the temperature of the condensate is lower than the steam temperature and in a steam line that is horizontal or pitching upward from the source of steam. A thermal pumping action must exist to start the hammer. It is most violent when the main is dead ended by a blank or closed valve.

At points in the distribution system where we anticipate the possibility of water hammer, we have installed rupture diaphragms.

For the past several years we have used solid pour construction (Fig. 2) whenever we are in an area where, due to the elevation of the city sewers, we anticipate flooding a possibility.

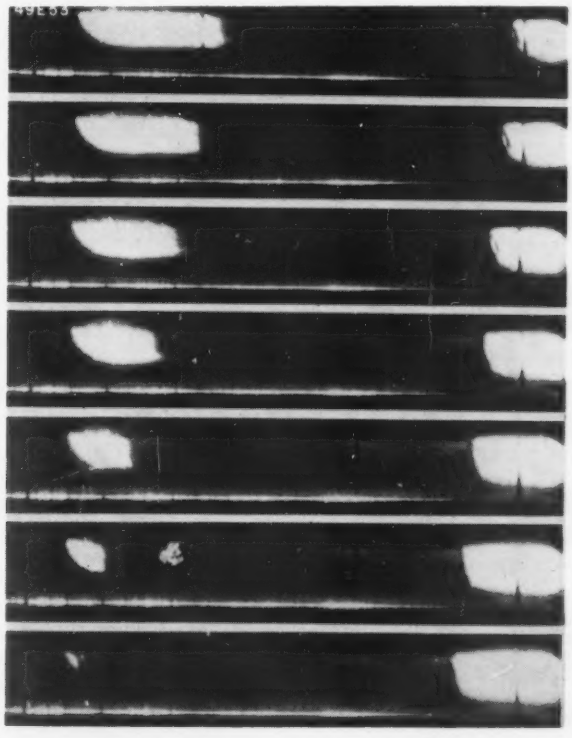
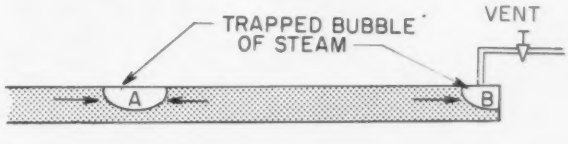


Fig. 6 Consecutive frames of motion pictures of water hammer in 2-in. glass tubing

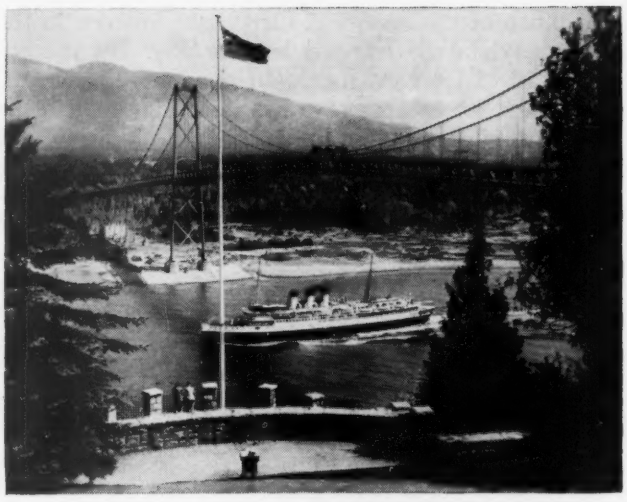
Fig. 7 Effect of position of trapped steam upon water hammer A—Condensation moves two columns of water at mid-position of the bubble B—At dead end only one column is moving and almost all of the energy is manifested at the end as water hammer



During the last years, we have been installing traps in our manhole drains that will close if the flow to the city sewers reverses.

For several years, we have used cast steel valves and expansion joints. Welding is used in the new construction. When making repairs we try to eliminate as much cast iron as practical.

Queen Elizabeth Park on Little Mountain provides a magnificent view of Vancouver, the harbor and the mountains beyond



Lions Gate Bridge links Vancouver's Stanley Park with the mountainous areas to the north

Vancouver calls

With the well-deserved reputation of being one of the world's most beautifully situated cities, Vancouver, B. C. will be host to ASHRAE for the 67th Annual Meeting, June 13-15.

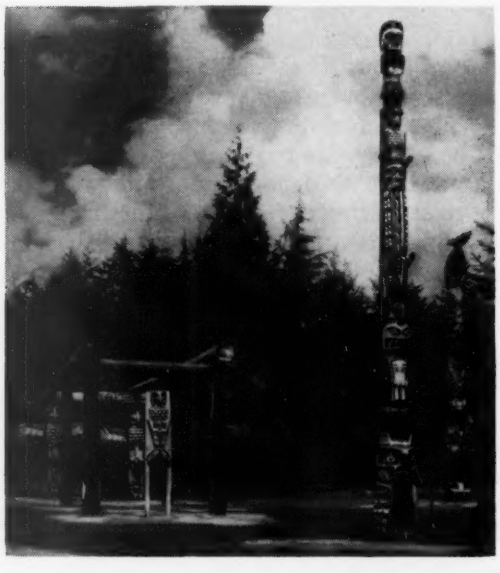
There will be a 3-day technical program during which 16 papers will be presented and 3 symposiums will be held. There will be Forums, too.

Aside from its own natural attractions, Vancouver is close to Victoria and its largely unspoiled charm, to Banff and Jasper in the fabulous Canadian Rockies and, indeed, to the whole Pacific Northwest.

Vancouver says, "Come and stay awhile".

Capilano Canyon has its torrent spanned by a thin suspension bridge

Nostalgic of a not wholly vanished past, totem poles and lodges are preserved for visitors



Dallas Symposium debates the ideal

Psychrometric chart

Five well known ASHRAE members brought as many viewpoints to a lively discussion, carried over to a supplementary session. Here is a news report of the highlights of a search for facts which may lead to a new and greatly altered form and character of Society-recognized chart. ASHRAE Bulletin will offer complete record.

Can the chart be improved?

C. M. ASHLEY
Presidential
Member
ASHRAE

A good psychrometric chart should be more than an expression of the thermodynamic interrelationships of air and water vapor. It should also be a working tool for the solution of psychrometric problems. It should satisfy four requirements:

1. The chart should be easy to understand
2. Easy to use
3. Correct thermodynamically
4. As complete as practicable

If the psychrometric chart is to have the broadest acceptance, it must meet the needs of a number of different kinds of people. It should be easily used and understood by the field engineer and salesman who use it as an everyday tool to figure the capacity of air conditioning jobs or to illustrate the psychrometric processes to the customer. It should be easy to understand and correct thermodynamically for the student who is learning the thermodynamics of air and water vapor mixtures. It should be as complete as possible to satisfy the needs of the designer of equipment and the person having special process requirements.

We tend to think of the individual state points as being the most important information to be derived from a psychrometric chart, but most of the problems which are to be solved involve processes in which the individual state points are the terminal conditions of the process. Thus, an important criterion in judging the effectiveness of a psychrometric chart is how simply and accurately it defines psychrometric processes.

Any consideration of a new form of chart should start by a comparison of the present charts with the requirements. The chart presently identified as that of ASHAE, offers a complexity of lines which results primarily from the use of a separate series of enthalpy and wet bulb lines. In order to make the chart usable, it is printed on a large sheet having approximately three times the dimensions and nine times the area of a standard 8½ x 11 in. sheet. The original chart is printed in two colors. Even with this blown up scale it is difficult to obtain an accuracy of reading of enthalpy closer than 0.05 Btu/lb because of the printing of the enthalpy and wet bulb lines in different colors. Even though the chart is sound thermodynamically, it is virtually unusable by the people who need to use it most.

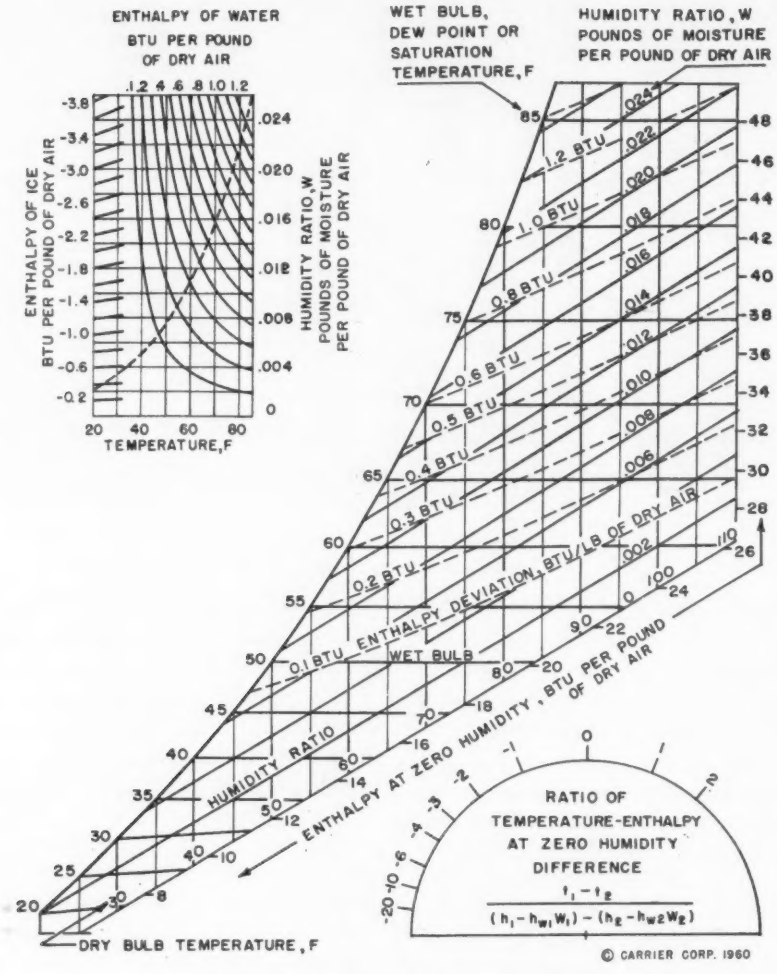
A simpler (ASRE identified) chart reduces the confusion of lines and the size of the chart required for good accuracy. A working chart of this type on a single 8½ x 11 in. sheet, can be used with an accuracy in determining the enthalpy relationship of better than 0.05 Btu/lb. For still better accuracy, larger charts of the same type are available. This increase in usability has been achieved at the expense of the complication involved in subtracting the deviations from the enthalpy at saturation.

When we consider a process involving the addition or removal of water, both charts require the use of an additional term for determining the correct value of the heat involved in the process.

Here is a suggestion for a psychrometric chart, retaining the general form of the conventional ones but instead of showing enthalpy at saturation above the saturation line, the enthalpy at 0 humidity is shown at the bottom and right hand side of the chart. Deviation lines have been replotted to be consistent with the enthalpy starting from the new base of 0 humidity. In the upper left hand corner is a small chart for the enthalpy of solid and liquid water using the same coordinates as are used for the main chart. (See following page.)

Values of the enthalpy of the liquid or solid water in the small chart with the corresponding values of enthalpy deviation at the wet bulb temperature corresponding to the water temperature and at the same value of humidity ratio are

C. M. Ashley, ASRE Past President, is Chief Staff Engineer, Research and Development Div, Carrier Corporation.



Suggested revision of chart that simplifies heat exchanger computations

identical. This identity makes possible a simplification of the computations of the heat exchanged in a psychrometric process.

Opportunity for simplification is possible by figuring the enthalpy of the leaving air and the enthalpy of the water rejected separately, the total enthalpy of the air plus rejected liquid water is figured together as the process enthalpy.

This is made possible by assuming that the water leaves the process at the leaving wet bulb temperature. The leaving process enthalpy is obtained by adding to the enthalpy of the leaving wet bulb at 0 humidity the enthalpy of the water per lb of dry air at the leaving wet bulb temperature and at the entering humidity ratio.

A similar simplification can be used when adding heat and moisture as in a cooling tower or evaporative condenser. For both humidifying and dehumidifying, the correction term is equal to the difference between the entering and leaving wet bulb temperature multiplied by the higher humidity ratio.

There is one significant difference between the humidifying and dehumidifying process: The entering water temperature for a humidifier is not usually as closely related to the entering wet bulb temperature as the leaving water temperature of the dehumidifier is tied to the leaving wet bulb temperature. However, the design water temperature is usually strongly influenced by the design wet bulb temperature and is seldom more than a few degrees different. Thus, it is probable that for most cooling tower and other processes involving humidification, an error of less than one per cent would be made by assuming a coincidence between the entering wet bulb and entering water temperatures.

There is nothing revolutionary about the proposed chart, but it does represent an evolutionary combination of ideas from a number of previous sources to provide a chart of improved usability. The general form of the chart and the use of enthalpy at 0 humidity are from Dr. Carrier. The idea of enthalpy deviation and the use of a separate chart of enthalpy of the liquid and solid water are from Palmatier and Wile. The uses of the coordinate system are from Mollier by way of the ASHAE chart and the ideas for the altitude chart come from Goodman, Karig and others. The contributions of Goff and his associates to the refinement of the psychrometric properties and the thermodynamic concepts should also be recognized.

High altitude charts

Within large areas of New Mexico, Arizona, Utah and Colorado there are elevations of from 4000 to 8000 ft, where sea-level (ASHAE) psychrometric charts are not usable.

A set of high altitude charts to the same scale and arrangement as the ASHAE chart might improve the accuracy of air conditioning design there.

Since the Goff and Gratch tables in the ASHAE GUIDE are for sea level, new tables must be calculated for specific elevations. The zero enthalpy used in these tables is an arbitrary value, not absolute. In solving air conditioning problems by means of these graphs and tables, only enthalpy differences may be used.

To construct new charts from tables calculated as above, certain additional data are needed and with these, charts may be constructed to any scale, using the basic coordinates of enthalpy and

Roger Haines is a Consulting Engineer with Bridgers and Paxton.

ROGER HAINES
Member ASHRAE

specific humidity. The charts discussed here were constructed to the same scale and with the same slope of enthalpy lines as used on the ASHAE sea level chart. Certain comparisons can then be made.

1. Dry bulb temperature lines are unchanged with altitude.

2. The saturation curve and relative and per cent humidity curve move to the left as altitude increases. That is: for a given dew point temperature h_s is higher at higher altitudes.

3. As altitude increases, specific volume decreases and at a given temperature and relative humidity, specific humidity increases.

A new look at coordinates

J. L. THRELKELD
Member ASHRAE

If a psychrometric chart is considered as a pure nomograph, any arbitrary choice of coordinates is permissible, as long as good line intersections are obtained. However, the Mollier-type chart has several fundamental advantages compared to a chart with t-W coordinates. With h-W coordinates lines of thermodynamic wet-bulb temperature are identically straight, whereas on t-W coordinates such lines have curvature.

The specific advantage of the Mollier-type chart occurs in the solution of a steady-flow problem. One example is that of adiabatic mixing of two air streams. On h-W coordinates, the mixture state lies on an identical straight line connecting the state-points of the two original air streams. On t-W coordinates, the same statement is only approximately true. The purpose here is to introduce a new form of psychrometric chart applicable to many different barometric pressures.

The most precise method of making psychrometric calculations involves methods of statistical mechanics. Goff and Gratch prepared tables of properties for sea-level pressure by this procedure.

A new psychrometric chart of the Mollier-type has been prepared. Its most important feature is provision for complete psychrometric solutions for any barometric pressure from 10 to 14.696 psia. The chart is for the normal range of dry-bulb temperatures from 0 to 120 F where most air conditioning problems occur.

Construction of the chart followed closely the geometrical method given by Goodman. The 80 F dry bulb temperature line is made vertical. The enthalpy lines are inclined with respect to the horizontal humidity ratio lines by an angle of 37° –15′. The scale factor of the chart is 833 Btu/lb_w. Calculations for the chart are primarily made on the premise that atmospheric air is an independent-imperfect gas mixture of dry air and water vapor.

The chart shows six saturation curves. Since these are rather closely spaced, saturation points for in-between pressures may be located fairly accurately by visual interpolation. The region to the right of any saturation curve may be considered as a single chart for the barometric pressure associated with the saturation curve. The region to the left of any saturation curve represents a fog condition.

The psychrometric chart herein discussed offers advantages over previous ones in that it allows convenient solutions for a wide variety of problems with atmospheric air for the range of barometric pressures commonly encountered in air conditioning work.

Two additional psychrometric charts of a similar type are being prepared. One chart will cover the temperature range of –60 to 20 F while the other will cover the range of 90 to 250 F.

J. L. Threlkeld is Professor of Mechanical Engineering, University of Minnesota.

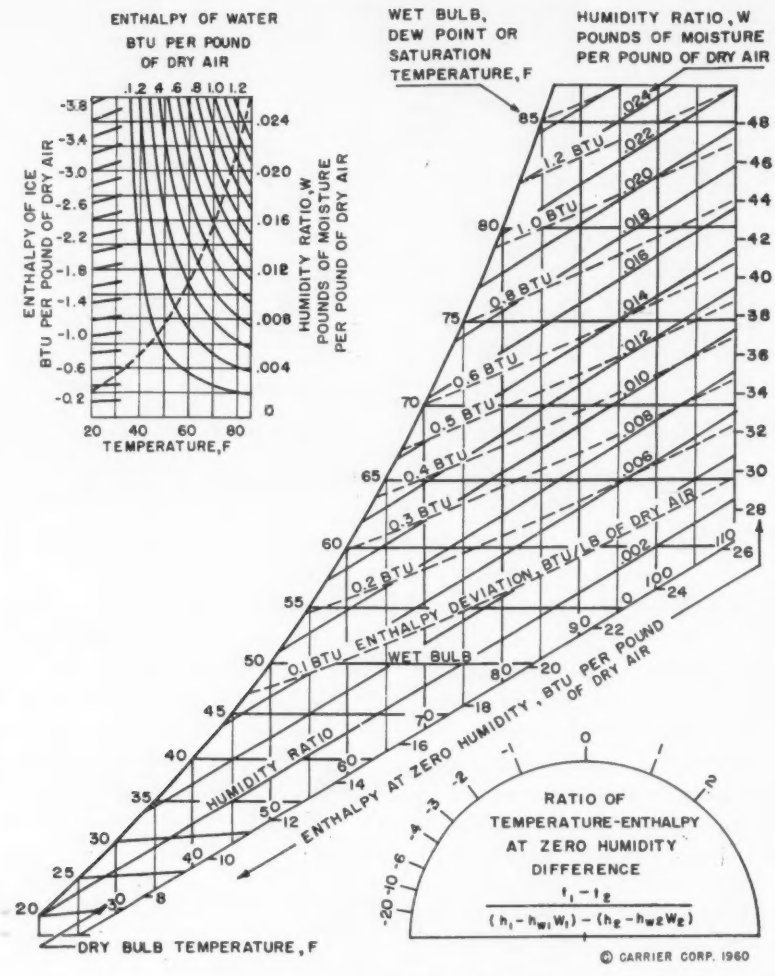
From the user's viewpoint

D. D. WILE
Fellow ASHRAE

Psychrometric charts are probably the most widely used graphical devices of the refrigerating and air conditioning industry. Their principal purpose is to show the relation between six major properties of moist air: dry bulb temperature, wet bulb temperature, moisture content (humidity ratio), relative humidity, enthalpy, and specific volume; and to provide graphical solutions to processes where air changes from one condition to another. The possible arrangements of coordinates and parameters are almost unlimited, with the result that psychrometric charts have appeared over the years in a wide variety of forms. An important factor has been the problem of presenting a network of so many variables in a form that would be easily and accurately readable.

Over the years psychrometric charts published by our two former Societies have run the gamut of size and arrangement, from those that were overly-simplified to those that were overly-complicated. The present Society chart, due to its

D. D. Wile, ASHRAE President, is Vice President of Recold Corporation.



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The chart shows six saturation curves. Since these are rather closely spaced, saturation points for in-between pressures may be located fairly accurately by visual interpolation. The region to the right of any saturation curve may be considered as a single chart for the barometric pressure associated with the saturation curve. The region to the left of any saturation curve represents a fog condition.

The psychrometric chart herein discussed offers advantages over previous ones in that it allows convenient solutions for a wide variety of problems with atmospheric air for the range of barometric pressures commonly encountered in air conditioning work.

Two additional psychrometric charts of a similar type are being prepared. One chart will cover the temperature range of −60 to 20 F while the other will cover the range of 90 to 250 F.

J. L. Threlkeld is Professor of Mechanical Engineering, University of Minnesota.

From the user's viewpoint

D. D. WILE
Fellow ASHRAE

Psychrometric charts are probably the most widely used graphical devices of the refrigerating and air conditioning industry. Their principal purpose is to show the relation between six major properties of moist air: dry bulb temperature, wet bulb temperature, moisture content (humidity ratio), relative humidity, enthalpy, and specific volume; and to provide graphical solutions to processes where air changes from one condition to another. The possible arrangements of coordinates and parameters are almost unlimited, with the result that psychrometric charts have appeared over the years in a wide variety of forms. An important factor has been the problem of presenting a network of so many variables in a form that would be easily and accurately readable.

Over the years psychrometric charts published by our two former Societies have run the gamut of size and arrangement, from those that were overly-simplified to those that were overly-complicated. The present Society chart, due to its

D. D. Wile, ASHRAE President, is Vice President of Recold Corporation.

large size, multiple folding and complex pattern of lines, is rarely used by engineers in their day-to-day work. Use of this chart appears to be confined to only a small percentage of our members. While the objectives of precision and accuracy are greatly to be recommended, we must not be carried away by such considerations to the point where we fail to serve the needs of our members.

After discussing psychrometric charts with many engineers who are required to use such charts in their day-to-day work, it is my conclusion that the Society should produce a chart having the following general characteristics:

The chart should be printed on a letter-size sheet, 8½ x 11 in., in a single color and on semi-transparent paper suitable for "blueprinting."

These charts should be made available in pads and carry the Society's name, along with space so that the user's name might also be imprinted.

Two temperature ranges will undoubtedly be required in order to cover both refrigeration and air conditioning applications of various kinds.

Consideration should be given to separate charts for high altitudes, especially in the air conditioning range. The construction of as few as two charts, or possibly even one, for high altitudes would satisfy a great need.

The general arrangement of principal coordinates now appears to be well established on charts in general use by the refrigerating and air conditioning industry, this arrangement being exemplified by both the ASHAE and ASRE charts. There appears little doubt that the basic coordinates should be moisture content and enthalpy (ASHAE chart) rather than moisture content and dry bulb temperature (ASRE chart). The enthalpy coordinate may be rotated to bring the dry bulb lines substantially vertical, thus the selection of enthalpy in preference to dry bulb as one of the basic coordinates does not change the general chart arrangement.

Use of enthalpy as one of the coordinates does not require that the enthalpy lines appear on the finished chart. The fact that the enthalpy and the wet bulb lines are so nearly parallel causes confusion if they are both shown. A practical solution is to omit the enthalpy lines in favor of enthalpy deviation contours and a scale of enthalpy at saturation.

Relative humidity is so well established in the refrigerating and air conditioning industry that its exclusion, at this time, would render any chart impractical. The use of both relative humidity and degree of saturation causes unnecessary complication. Since degree of saturation can easily be calculated by the division of two moisture contents, it appears desirable to omit this latter function from the chart.

It is my contention that a chart of this nature would find wide usage in our industry and, in making it available to our members, we would be providing them with a highly needed service.

WHO'S WHO IN ASHRAE

Insofar as possible, these listings will each appear twice a year

ASHRAE OFFICERS, COMMITTEES
See page 80, this issue

REGION AND CHAPTER OFFICERS
See page 78, October JOURNAL

RESEARCH AND TECHNICAL COMMITTEES
See page 74, February JOURNAL

STANDARDS COMMITTEE
See page 89, November JOURNAL

INTER-SOCIETY COMMITTEES
See page 66, February JOURNAL

We must understand enthalpy

J. A. GOFF

I conclude from the Psychrometric Chart meetings in Dallas that enthalpy is widely misunderstood, and that the requirements of thermodynamic consistency in the presentation and practical use of psychrometric data can not be well appreciated until enthalpy is much better understood.

Now facing our Society is the opportunity to insist upon thermodynamic consistency within the accuracy of existing knowledge as an essential feature of its psychrometric chart or charts.

A chart that, however accurate it may be, either lacks thermodynamic consistency or, having it, conceals it out of deference to tradition, is not likely to make a lasting contribution to the welfare of the profession that the Society represents.

It is clear that my paper must make a bigger contribution to a better understanding of enthalpy than does the mimeographed material I had with me in Dallas.

I wish to set forth some of the requirements of thermodynamic consistency that the new psychrometric chart or charts must meet to achieve relative permanence and accomplish sound educational objectives. This is not an easy task, but I want to undertake it as soon as possible.

I suggest there should be a set of isobaric charts with mixing ratio and enthalpy as ordinates and abscissa respectively; relative humidity is not the best interpolant for use in thermodynamic properties; one of the sets should be for standard atmospheric pressure.

J. A. Goff is Professor of Thermodynamics, School of Mechanical Engineering, University of Pennsylvania.

BULLETINS and CATALOGS

Polystyrene Foam Board. Genafoam, an expanded polystyrene foam board, is the subject of a 12-page bulletin listing its varied uses and physical properties. Applications shown include perimeter insulation, core walls, roof insulation and sandwich construction. Illustrations depict methods of installation, ease of handling and cutting the billets, boards and logs.
General Foam Plastics Corporation, 801 Mt. Vernon Ave., Portsmouth, Va.

Defrost Controls. Designed for use by distributors of automatic defrost controls and their customers, this replacement chart lists manufacturer's stock numbers of refrigerators with those of the timers that defrost them automatically. Also listed are the cam, pin, pressure and special adjustments required to fit each unit to the applicable refrigerator. A separate section lists pertinent replacement information for the 8100 Series of controls. Bulletin X-TD-295.
Paragon Electric Company, Two Rivers, Wisc.

Cooling Tower Water Treatment. Mounted on the side of the equipment, the Chemicator is a small, lightweight, closed reservoir through which a portion of the recirculating water flows. On its upper side, a sleeve holds a weather-sealed plastics tube containing a sequence of variously formulated compressed chemical briquettes, made of polyphosphates and organic chelates to remove and prevent the formation of scale, organic corrosion inhibitors to remove and prevent the formation of rust, together with automatic pH, algae and slime controls. As the briquettes are gravity-fed into the water flowing through the reservoir, they slowly dissolve and are carried into the entire system. Descriptive of this process is a six-page folder.
Erlen Products Company, Burbank, Calif.

Fasteners. Driving cycles, strength data, typical applications, grip ranges, significant dimensional data, hole size recommendations and installation notes for each fastener in this line are included in 24-page Bulletin 8-483. Presented are descriptions of a variety of tension, featherweight, self-broaching and self-sizing fasteners, and pull-through, friction-lock and lock-spindle self-plugging blind rivets.
Huck Manufacturing Company, 2480 Bellevue Ave., Detroit 7, Mich.

Industrial Catalog. General product categories covered in 40-page Catalog 204 are hose types, fittings, adapters, self-sealing couplings and miscellaneous items such as support clamps and protective sleeves. Included is a hose selector chart listing the various applications and fluids for which specific hose types are recommended. Instructions for ordering and assembling hose lines are also provided.
Aeroquip Corporation, Jackson, Mich.

Dust Collectors. Included in 16-page Bulletin 1828 is a list of typical industrial applications of Series 342 dust collectors, itemizing those for power plants, steel production, cement and aggregate production, chemical and petroleum processing, food and grain processing and general manufacturing. A cutaway is used to explain operating characteristics and construction features are described and illustrated. Featured in the bulletin are a pair of nomogram presentations designed to simplify engineering calculations relating to the series. An accompanying table provides necessary dimensional and physical data for determination of installation requirements.
American Radiator and Standard Sanitary Corporation, Industrial Div, Detroit 32, Mich.

Expansion Joints and Flexible Pipe. Used in recirculating water systems, hot water lines, water cooler condenser lines, washer systems, boiler feed lines, chilled water lines and pump discharge lines to absorb vibration and noise, prevent stresses due to pipe expansion and contraction and to compensate for minor misalignments, this line of expansion joints and flexible pipe is covered in six-page Catalog 850. Other flexible units included are elbows, tees and standard flexible pipe with full-faced ends.
General Rubber Corporation, 57 Summit St., Tenafly, N. J.

Thread Form. Reported in 32-page Design Manual 5930 is data relating to Equa-Stress modified UNF-3 thread form which, installed in a nut, is cited as doubling the fatigue endurance of a standard high tensile bolt. Included in the manual are 17 pages of findings concerning the basic nature and causes of fastener fatigue, six detailed drawings of self-locking nuts and applicable fatigue performance test results.
Elastic Stop Nut Corporation of America, 2330 Vauxhall Rd., Union, N. J.

Sliding Gate Regulators. Features of these cast-steel sliding gate regulators include minimum maintenance, tight shut-off, balanced action, straight through flow, short stroke, accurate control, all-metal construction and linear flow characteristics. Flyer JNP-5.
OPW - Jordan Corporation, 6013 Wiehe Rd., Cincinnati 13, Ohio.

Thermo-Anemometer. Model GGA2C, operating on a standard flashlight battery in the instrument handle, measures both air velocity and temperature. This thermo-anemometer, together with a hot wire anemometer, resistance thermometer and six models of temperature probes, is the subject of a four-page bulletin.
Gelman Instrument Company, 106 N. Main St., Chelsea, Mich.

Evaporative Condensers. Applicable to refrigeration and air conditioning installations from approximately ten ton refrigeration up, 12-page Catalog C-2 contains a table from which selection of a correctly-sized condenser can be made for ammonia refrigeration in 46 sizes from 12 to 354 ton per unit and for halogenated hydrocarbon refrigerants in 23 sizes from 15 to 425 ton, at standard conditions. Illustrations of different types of condensers and condenser features and diagrams showing construction and operation are given. Physical data includes general specifications, dimensions and weights.
Niagara Blower Company, 405 Lexington Ave., New York 17, N. Y.

Equipment. Covering items for the refrigeration and air conditioning industries, Catalog R-59 includes descriptions of driers, filters, strainers, liquid indicators, water regulating valves, water bubblers, hoses, clamps, clips, straps and hangers.
McIntire Company, Livingston, N. J.

Couplings. Ten-page Bulletin 5103 (revised) covers the complete line of Sure-Flex flexible couplings, including the new Junior couplings with flanges of zinc alloy AF40A and large-size bushed couplings fitted with interchangeable, QD-type tapered bush-

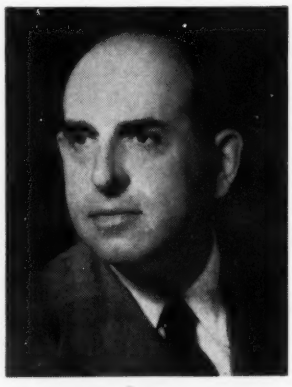
(*Continued on page* 92)

Nominations

for election of ASHRAE Board of Directors

The following nominations for vacancies upon the ASHRAE Board of Directors have been made by a Nominating Committee as specified in the By-laws of the Society and Agreement for Consolidation. The Committee, whose Chairman is P. B. Gordon, and with representation by Leon Buehler, Jr., as a member of the last prior Nominating Committee, consisted of S. F. Gilman (Region I), G. C. Davis (Region II), W. A. Siegfried (Region III), R. K. Rouse (Region IV), L. C. Burkes (Region V), D. S. Falk (Region VI), D. M. Mills (Region VII), G. H. Meffert (Region VIII), J. K. James (Region IX), and R. M. Westcott (Region X) and these selections by the Board of Directors: R. A. Baker, J. R. Caulk, Jr., H. G. Murray, P. N. Vinther, R. A. Sherman and B. W. Farnes.

FOR TREASURER, JUNE 1960 – JANUARY 1961: JOHN E. DUBE



President of Alco Valve Company, with which he has been associated for some 20 years, he has written numerous papers and articles, many of them appearing in various technical publications.

Joining the Society in 1940, the Treasurer-nominee has participated as a Director of the ASRE Council, 1958-59, and served on the Industrial Relations, International Affairs and Research Exhibits Committees, in addition to being Regional Director for Region IX, 1955-58.

ASHRAE activities are membership on the Board of Directors, Exposition Committee, Finance, Advertising, and RAC on Control.

He is affiliated with the St. Louis Chapter of which he is past chairman.

FOR DIRECTORS:

REGION VIII

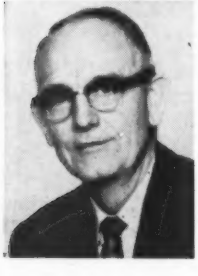
JUNE 1960 – JUNE 1962: W. J. COLLINS, JR.

A Consulting Engineer in Oklahoma, he joined ASHAE in 1949. Activities on the national level include membership on Chapters Conference Committee, 1950-54, and chairman in 1954. Nominating Committee, 1955, Publications Committee, 1955-57, and chairman in 1957. Regional Director, 1959-60, of Region VIII.

He has served in all Chapter offices and on Board of Governors of the Central Oklahoma Chapter.

REGION VII

JUNE 1960 – JUNE 1962: J. F. NAYLOR, JR.



Partner and Manager of J. F. Naylor & Company, he was Secretary of the St. Louis Chapter of ASHAE for two years, 1951-53, and helped organize the Baton Rouge Chapter of which he was first Vice President, 1955-56. He was also elected President of that Chapter for the 1956-57 term.

In 1952 he served as Special Events Committee Chairman for the annual meeting of the Society at St. Louis and was Regional delegate in 1956 to Atlanta and in 1957 to New Orleans.

REGION X

JUNE 1960 – JUNE 1962: T. J. WHITE

Branch Manager of American-Standard Industrial Div, he joined ASHAE as a junior member in 1937, later becoming associate member and finally a member in 1950. Serving on various posts within the Golden Gate Chapter of ASHAE and ASHRAE, he was President from 1952 to 1953.

He was the Chapter delegate to the ASHAE National Convention in Chicago in 1953 and the alternate delegate to the National Convention in Philadelphia in 1955. He served on the Reception Committee during the summer meeting in 1940, Chairman of the Reception Committee during the summer meeting in 1955, and Chairman of the Ladies Committee of the Regional meeting in 1959, all taking place in San Francisco.

Elections will be made by ballots counted at the 67th Annual Meeting of the American Society of Heating, Refrigerating and Air-Conditioning Engineers in Vancouver, B. C., June 13-15.

FOR DIRECTORS AT LARGE:

JUNE 1960 – JUNE 1962: W. S. HARRIS

Research Professor at the University of Illinois, he took part in a project conducting research on steam and hot water heating systems, that involved the construction of a six-room house in which to run the tests and its subsequent operation.

Author of many articles, his activities in ASHRAE have included membership on various research committees. He has been a member of predecessor Society, ASHAE, Panel Heating Committee, 1947-57, and chairman in 1957; Heating Load Committee, 1945-55, and chairman, 1951-52; and GUIDE Committee, 1951-53, and chairman, 1953.

JUNE 1960 – JUNE 1962: W. L. McGRATH

Director of Development for Carrier Corporation, he has authored numerous technical articles and is the holder of many patents.

Joining the Society in 1940, he has participated on the ASRE Standards Committee, 1956-58, Technical Committee Chairman, 1957-58, Proposed Standards, 1956 to present and chairman of that committee in 1956.

Chairman of the Air Conditioning Conference, 1957, he is affiliated with the Central New York Chapter.

JUNE 1960 – JUNE 1962: J. W. MAY

Author of a number of papers published in American and foreign technical magazines, he has assisted in preparation of chapters for the ASHRAE GUIDE and was the author of the chapter on "Viscous Impingement Filters" for the reference book on Air Pollution which covered the Proceedings of the U. S. Technical Conference on Air Pollution.

Director of Technical Training, American Air Filter Company, he represented the former ASHAE in 1957 on the Committee on Abstracting Services of The Engineers Joint Council. He has been chairman and active on the ASHAE Publications Committee; member of the Chapters Conference Committee and of the TAC on Air Cleaning. Currently, he is a member of ASHRAE's Technical Coordinating Committee, and Vice Chairman of the Publications Committee.

JUNE 1960 – JUNE 1962: AXEL MARIN

Professor of Mechanical Engineering at the University of Michigan, he has been a consultant to architects and mechanical engineering firms. Joining ASHAE in 1935, he was a member of the Board of Governors from 1953-55. Activities include membership in TAC on Psychrometry, 1940-43; TAC on Flow of Fluids, Pipes and Fittings, 1940-42; TAC on Air Conditioning Requirements of Glass, 1940-44; Committee on Research, 1940-42; GUIDE Committee, 1944; Publications Committee, 1953-55.

Author of numerous articles, he is affiliated with the Michigan Chapter.

JUNE 1960 – JUNE 1962: G. B. ROTTMAN

A Consulting Engineer, Greensboro, N. C., he was elected to membership in predecessor ASHAE in 1944 and to ASRE in 1949. Affiliated with the North Piedmont Chapter (ASHAE) and the Carolina Section (ASRE), he served in the North Piedmont Chapter as Secretary in 1950 and President in 1958.

Activities include those of Regional Director, Region VI (ASRE), 1957-58; he is serving currently as Assistant Director, Region IV, ASHRAE.

JUNE 1960 – JUNE 1962: V. D. WISSMILLER

Manager of Manufacturer Sales for Minneapolis-Honeywell, he has been active in the design of Control Systems and directing all control installations for such projects as the Soldiers' Memorial Building, National Guard Armory, Civil Courts Building and Public School Buildings in St. Louis, Mo.

He was Chairman of ASRE Twin Cities Section, 1957-58; General Chairman, ASRE Summer Meeting at Minneapolis, 1958; chairman of the Nominating Committee (ASHRAE) 1959. His present activities include membership on the Public Relations Committee; Professional Development Committee; associate chairman of the Air Conditioning Committee; and a member of the ASHRAE GUIDE AND DATA BOOK Committee.

His affiliation is with the Minnesota Chapter.

In order to comply strictly with the provisions of the By-laws, a Special Nominating Committee has made the exact same nominations for each of the offices above named and said petition has been filed with the Executive Secretary as required by Section 8.8.18, and is open to the inspection of any voting member.

April 1, 1960

R. C. Cross, Executive Secretary

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C. F. Holske

PLASTICS NEED ENGINEERING-QUALITY CONTROL

(*Continued from page* 51)

quality producers in each type of application and utilize their experience, rather than attempting to engineer and design these parts with men who are not actually working with the latest techniques of the process.

There are danger steps all the way in planning the manufacture of a component part. First, proper selection of a source of supply. Second, proper design. Third, selection of material. Fourth, tool design. Fifth, gating. Sixth, cycle operation of the machine. Seventh, mold temperature control. Eighth, quality control of all factors of production.

To accomplish the ultimate of perfection the molder or fabricator should be called in as soon as preliminary designs are complete. At this point, the molder becomes fully informed with what is desired in a part and can assist in the design and specifications to best accomplish the desired results.

The price battle within the refrigerator industry has forced engineering and purchasing departments to go beyond the safe limits in reduction of wall sections and the selection of proper materials to do a lasting quality job. As a result, both the plastics and the appliance industries are suffering from maintenance costs and lack of public acceptance. On the average refrigerator, plastics have made a cost savings of approximately $10 over the next best available material, considered to do a like job in appearance and design.

Why not up-grade the box and the industry with proper design and still give a $5 savings per box? Often, a small concession in the original design or specification can make the difference between a good and bad part.

Often, specifications, as found on original drawings, are kept in the engineering department and have no meaning left after the first part is produced or the original tool is completed. Here manufacturing costs can be improved by using the proper partnership tactics. An automotive manufacturer has made a satisfactory approach to this problem by supplying revised prints which include only meaningful dimensions such as distance between mounting holes—warp tolerances—color specifications—etc., that are significant in the converting process after the original samples are approved. This reduces unnecessary rejects in the vendor's plant and as a result reduces cost to the appliance manufacturer.

This works with the automotive manufacturer in that the part designed by the engineering department is completely drawn and duplicated without dimensions. The original then is fully dimensioned and sent to part suppliers for tooling purposes. Once the tool is completed, quality control joins assembly to test sample parts for fit and performance, which may result in tool changes, when the tool is approved for production. Quality control then sets up a list of critical dimensions – only those affecting assembly and performance. These critical dimensions are then placed on the duplicated copy to provide a standard for both the supplier's and customer's quality control groups. This has proved quite effective as a major cost cutting factor.

REASONS FOR FAILURE

The problem of excessive plastics part failure is the result of three distinct, but related, causes at work in various areas of the Refrigerator Industry. They are: Incomplete knowledge of plastics properties, incomplete understanding of designing with plastics and excessive cost cutting in the use of plastics.

As suggested previously, by selecting qualified, quality suppliers for your plastics requirements and working with them on a given type of work best suited for their fabrication, you will assure improved results. Overall costs will not be increased and a better quality product will emerge from future production.

Meetings ahead

April 4-7—Oil Heat Institute of America, Annual Convention, New York, N. Y.

April 4-7—Oil Heat Institute of America, 23rd National Oil Heat and Air Conditioning Exposition, New York, N. Y.

April 5-7 – Building Research Institute, Spring Conferences, New York, N. Y.

April 25-28 – National Association of Refrigerated Warehouses, Annual Convention, Bal Harbour, Fla.

April 27-30 – 3rd Western Air-Conditioning, Heating, Ventilating and Refrigeration Exhibit and Conference, Los Angeles, Calif.

May 1-3 – North American Heating and Air Conditioning Wholesalers, Spring Convention, New Orleans, La.

May 19-21 – Refrigeration Research Foundation, Annual Meeting, Denver, Col.

May 22-25—Industrial Heating Equipment Association, Hot Springs, Va.

May 23-26—American Society of Mechanical Engineers, Design Engineering Conference, New York, N. Y.

May 23-26—Design Engineering Show, New York, N. Y.

June 6-9 – Institute of Boiler and Radiator Manufacturers, Annual Meeting, Absecon, N. J.

June 6-9 – National District Heating Association, 51st Annual Meeting, Asheville, N. C.

June 6-10 – Institute of Appliance Manufacturers, Cincinnati, Ohio.

June 13-15—American Society of Heating, Refrigerating and Air-Conditioning Engineers, 67th Annual Meeting, Vancouver, B. C.

June 15-17—1960 Heat Transfer and Fluid Mechanics Institute, Stanford University, Stanford, Calif.

People

KLEINKAUF

GOULD

Henry Y. Kleinkauf, President of Natkin & Company since 1950, has been named Executive Chairman of the Board of Directors, while **Henry E. Gould,** formerly Executive Vice President and Treasurer, has been named President and Treasurer. Both men have been with Natkin for approximately 30 years and are professional engineers.

John M. Thompson has been named Vice President and General Manager of Itemlab, Inc. Leaving government civil service after 25 years, he will be responsible for operations in the fields of environmental testing, design, research and development. During the past ten years he has held the position of Laboratory Chief at Rome Air Development Center's Test Facilities Laboratory.

John R. Caulk, Jr. has been elected President of Hussmann Refrigerator Company, advancing from his position as Vice President. He has been with the organization since 1937. Active in the former ASRE, he has been a member, since 1953, of the Standards Committee and was Vice Chairman of the Membership Committee in 1951-52. Several articles he has written have appeared in REFRIGERATING ENGINEERING.

Kenneth A. Merz has been appointed Engineering Manager of Air Impeller Div, Torrington Manufacturing Company. Replacing **C. A. Hathaway,** now Assistant General Manager of the Div, he will supervise all design and development of impeller products, air and sound laboratory testing facilities and application engineering. Educated at Yale University, he joined the company as a design engineer, served as Engineer in Charge of Product Development from 1953-56, and then as Assistant Chief Engineer. He was appointed Production Engineering Manager last year.

Fred Kaiser, Manager of the eastern region for Minneapolis-Honeywell Regulator Company, has been appointed Vice President of that area. Eastern Region Manager since 1953, he joined the company in 1926, and is now in charge of all Honeywell sales and service activities in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut and parts of New York, New Jersey and Pennsylvania.

Milton L. Hoagland advances from his position as Manager of Centrifugal Compressor Sales, Trane Company, to Manager of Refrigeration Applications Engineering. Joining Trane in 1931, he was assigned to the Air Conditioning Sales Dept as an applications engineer and in 1941 was promoted to Manager of the Refrigeration Sales Dept. In 1956 he advanced to Manager of Centrifugal Compressor Sales. An authority on refrigeration machines, he has written numerous articles on such equipment.

Horace W. Wilson, President of Quaker City Cold Storage Company, was recently re-elected President of the Pennsylvania Warehousemen's Association for his 26th term in office.

R. H. Tull, ASHRAE Second Vice President, has been appointed Manager, Product Engineering Dept, Columbus Works, Westinghouse Electric Corporation. Currently a member of the Executive Committee, Chairman of the General Administrative and Coordinating and Regions Central Committees, ex-officio member of the Finance Committee and member and past-Chairman (1958-59) of the Publications Committee, he has been a member of the former ASRE since 1938. Previous activities include membership on the Technical, Advertising and Technical Coordinating Committees.

Roger F. Chesebro, appointed to the Engineering Dept of Fraser and Johnston Company, most recently directed refrigeration and air conditioning activities of Vendo Company and its subsidiaries. He is a past-Chairman of the Fresno Chapter of the former ASRE.

MOORE

James S. Locke and **Wesley R. Moore** have been elected Vice Presidents of Minneapolis-Honeywell Regulator Company, after having been active in a variety of sales and administrative posts during long careers with the company. Locke also has been named Vice President and General Manager of Brown Instruments Div in Philadelphia.

LOCKE

T. R. Kearney is retiring after 25 years with Ansul Chemical Company. An ASHRAE member since 1931, he is also a Charter Member of Garden State Chapter, Refrigeration Service Engineers Society.

James G. Coleman will head sales engineering activities in the Memphis area for Acme Industries, Inc. Affiliated with Southern Heater Company for ten years and assigned to this area since 1956, he has been in the refrigeration and air conditioning field since 1948.

Jack F. Spears, appointed Sales Engineer by Acme Industries, Inc., will cover the southern half of Florida, with headquarters in Miami. He has operated his own refrigeration and air conditioning business there since 1956, serving earlier in various engineering and executive capacities in Chattanooga, Tenn., Canal Zone and Colombia, S. A.

William A. Boone, formerly Vice President in Charge of Sales, has been appointed Executive Vice President and Treasurer of Bell & Gossett Company, succeeding **Clarence E. Pullum,** who died on January 8th. Joining Bell & Gossett in 1940 as a sales engineer in the Heat Transfer Dept, he was promoted to Assistant Sales Manager in 1947, Sales Manager in 1955 and Vice President in Charge of Sales in 1957.

Herbert Wolf, appointed General Manager of Crest Engineering, Inc., was Chief Engineer of the Research and Development Sect of Worthington Corporation's Air Conditioning and Refrigeration Div. Active in various professional and trade organizations, he is currently Secretary of the North Jersey Chapter and member and past-Vice Chairman, National Standards Committee, ASHRAE; Chairman, International Standards Organization of American Standards Association; and a member of the Technical Committee on Unitary Air Conditioners, ARI.

E. J. Burnett, in his capacity as Product Manager, will direct activities of Revco, Inc.'s newly formed Heat Pump Div. Previous to this assignment he served as Director of Quality Control and Production Manager. Before joining Revco in 1952, he was associated with Franklin Manufacturing Company's St. Cloud Div in an engineering and production capacity.

Others are saying

that . . . . . in a system with constant volume units, variations in static pressure in the duct system do not affect flow from the unit. Such desirable features have resulted in use of constant volume control in installations where it is not needed, even though it is more expensive than conventional control. To keep costs of high velocity double duct systems to a minimum, the system should be studied to determine if constant volume control is necessary for all units, if the system could be controlled with static pressure control alone, or if a combination of the two would be most economical. *Air Conditioning, Heating and Ventilating, February 1960, p 70.*

that . . . . . integrated lighting, air conditioning and sound control in a cited structure provides extensive flexibility for future applications. Not a luminous ceiling as conventionally known, this installation is composed of a series of continuous fixture units which, in addition to the illumination function, act as a sound barrier above the ceiling. Fixtures are spaced in both directions by runners which outline, but do not support, them and which receive movable partitions for access to the units. One of the runners is slotted and contoured to supply conditioned air and to exhaust it. *Architectural Record, February 1960, p 220.*

that . . . . . prior to selection of unit heaters, heat loss of a building should be calculated, with allowance made for losses caused by mechanical ventilators and natural ventilation through elevator shafts, open stair wells, monitor roofs or frequently opened doors. In locations with floors over unheated spaces or directly on the ground, ducts should introduce heated air at several points close to the floor, offsetting this source of heat loss. In general, the direction of the warm air stream should be parallel and close to the principal source of heat loss. *Refrigeration Service and Contracting, February 1960, p 14.*

They Wanted to Know

Inquiries of the month to ASHRAE Headquarters covered many points as to technical facts, standards, practices, personnel and published references. From these, the following have been selected and condensed as being those replies of some general interest and value to ASHRAE members.

WHY NOT CASTERS?

To ASHRAE:

Have often wondered why refrigerators are not equipped with casters. I know that the added manufacturing and sales cost might have some bearing. But what are some of the other reasons?

C. E.

Undoubtedly the reason that refrigerators are not equipped with casters is that in order to be effective, such supports would have to be quite large. This would mean that they would be undesirable as far as appearance, and in addition, costly. Refrigerators are moved only infrequently and the skids that are attached are apparently adequate. For such heavy appliances, casters would have to be quite wide and of soft material or they would mar the floor surface. We suggest that you contact the American Institute of Architects which is always interested in the design of appliances.

NOT FOR FREEZING

To ASHRAE:

A sanitary Standard for Commercial Refrigerators and Freezers for use in food service operations is being prepared by the National Sanitation Foundation. In developing this Standard the industry, public health and user groups, who are participating, would establish maximum temperature levels which would be permissible in such refrigerators and freezers. They have been able, based on other existing health standards, to arrive at a satisfactory temperature requirement for refrigerators. However, considerable difficulty has been experienced in obtaining a satisfactory requirement regarding the maximum permissible temperature in the freezer units. These freezers would be of the walk-in and reach-in types and used for the purpose of storing, for relatively short periods of time, frozen vegetables, meats, poultry, etc., not for freezing these products. What would be the maximum temperatures for such freezers?

T. S. G.

Comprehensive information on this subject is included in the 1959 edition, Refrigeration Applications Volume of the DATA BOOK. In the chapter on meat products, the following statement was made: "Storage temperature is the largest single factor affecting the quality of all frozen foods. Whatever care has been lavished on the production of a fine food will be for naught if the storage temperature is allowed to rise to 15 F for any length of time." It would be impossible to make a single statement as to the temperature requirement for all commercial refrigerators in order to adequately handle the many types of foods or products stored in such appliances since each specific product has its own storage requirements. There is a chapter in the Refrigeration Applications DATA BOOK on Commodity Storage Requirements which will indicate the temperature variables that would need to be considered. We also suggest that you contact the Commercial Refrigerator Manufacturers Association.

DOMESTIC FURNACE SIZING

To ASHRAE:

Would like to know the correct size of gas furnace for my home. I want 100 F temperature heating but am told 80 F temperature would be enough with a gas furnace. If the gas furnace were not the right size or of correct Btu rating would there be draft in the heating?

L. E.

We do not do consulting work and, therefore, would be unable to give any definite information as to the correct size of gas furnace for your residence. We suggest that you contact your local gas utility which would be able to recommend a heating engineer in the area able to do this. You are correct in approaching your problem on a Btu basis. Your heating equipment should be capable of providing the Btu's of heating required by your specific construction and if the ducts and registers in your system are properly designed, you should have no draft problems.

CAREER INFORMATION

To ASHRAE:

Our project for this semester is to accumulate information that will depict or dramatize the industries engaged in the manufacture of scientific products, also the materials used to manufacture these products. The objectives of this project are: To stimulate students' interests in the fields of science. To show the varying fields of science which offer potential employment. To offer the most recent advancements in the fields of science. In addition to obtaining brochures, we would welcome a display or samples which would illustrate the processes involved in the manufacture of your products.

H. A. C.

ASHRAE does not produce or manufacture any products. As an engineering society, our scope of activities includes the collection, correlation and dissemination of technological data covering areas of interest to our members. Our Education Committee, however, does publish a pamphlet, concerning the opportunities in engineering, which is distributed to high schools for vocational guidance use. The sort of equipment and displays that you are interested in would be available from individual manufacturers.

MOBILE REFRIGERATION

To ASHRAE:

The ASRE DATA BOOK contains names of manufacturers of refrigeration equipment and their products. I am interested specifically in equipment for Mobile Vehicle Refrigeration Systems and would like to know if the names of those 14 companies listed by the Government under that classification. Where may I obtain the names of those 14 manufacturers?

H. E. L.

Manufacturers' listing in the DATA BOOK for this type equipment is classified as "Truck and Trailer Refrigeration Systems". There are 19 manufacturers listed. We have no way of knowing, however, whether these 19 include any or all of the 14 manufacturers you state the government has reported. We suggest you contact the specific government agency that published the report and request a listing of the manufacturers.

RATINGS OF ROOM AIR CONDITIONERS

To ASHRAE:

The Standards and Inspection Section of the Purchase and Contract Division of the State of North Carolina recently activated an advisory committee on room air conditioners. This department would like to furnish the members with any standards, specifications, ratings, etc., available at this time. We would also like to know which organization of Btu ratings we should ask for on bids in order that we would be comparing all manufacturers' machines on the same basis.

L. D. U.

A standard on the rating of room air conditioners has been published by the National Electrical Manufacturers Association. This standard is used by all principal manufacturers of this type of equipment in the U.S. Our Society has at the present time a testing standard for all types of air conditioning equipment including room air conditioners which is presently being revised. Four separate standards are being developed. These will cover: Room air conditioners, unitary air conditioning equipment, heat pumps, and unitary heat-operated equipment. The revision for room air conditioners should be available by June.

Our standards policy

P. W. WYCKOFF
Chairman
ASHRAE
Standards Committee

At the June 1959 Lake Placid Meeting, the Operational Guide for the Standards Committee was approved by the Committee and by the Society Board of Directors. It was developed after two years of continuous study and careful thought regarding the role our Society should play in developing standards.

One of the most important points in the new Standards Policy is the difference between a rating standard and a testing standard. ASHRAE is a professional society and does not engage in commercial activities. Most of the ASHRAE standards are intended to supply sound technical information on methods of testing. They are not rating standards and the expression frequently seen on manufacturers' specification sheets "Rated in accordance with ASHRAE Standard ———" is not a correct statement. Our ASHRAE standards tell how it is possible to test a room air conditioner or a package unit for capacity; it does not tell what rating can be published on this product in advertising literature. There are a number of reasons for this.

The determination of a rating on which a customer can rely involves not only the method by which the product is tested but how well the product is duplicated in production. There are other commercial considerations. It is possible to design a unit with a high capacity but one which will not run under some summer temperatures. Such a rating would be meaningless. All these considerations are primarily commercial ones and our Engineering Society has no means of resolving disputes over what rating conditions should be set.

Members of a highly respected technical society are chosen for assignments on the basis of their individual technical competence. They do not represent their companies and cannot speak for them in commercial considerations.

A technical society has no means of policing ratings which are published. This cannot be done without actually checking products and entering into disputes with manufacturers; this type of activity tends to degrade the integrity and technical competence of the Society. These matters are properly within the province of a trade association and not ASHRAE.

In future standards, ASHRAE will even omit so-called peg points. A standard can describe how a window unit is to be tested without specifying that the inside temperature must be 80 F dry bulb and 67 F wet bulb. These peg points are to be determined by a trade association if a suitable one is available. If there is no trade association, peg points may be shown in an appendix to our standards and later removed when a reputable trade association publishes a rating standard.

Some years ago it was quite common practice for manufacturers to quote capacities on their units and label them as being in accordance with the ASRE or ASHAE standard. It was commonly known that many of these ratings were as much as 20 to 30% off from capacities obtained by the customer; yet our Society had no means of controlling or policing this bad situation.

Your Standards Committee feels that the above policy will preserve the technical integrity of our Society and at the same time perform an outstanding service in supplying the needed technical information for accurate testing. It is, of course, our hope that trade associations will refrain from developing testing standards and instead reference the applicable ASHRAE standard for testing and develop their own rating standard. We have had excellent relationships with many trade associations and other technical societies and feel that the ASHRAE standards represent a major Society contribution.

What ASHRAE Regions and Chapters are doing

Panel discussions were prevalent at mid-winter meetings, often presenting topics from the varying points of view of an architect, engineer, manufacturer and contractor. Bids, refrigerant piping and freeze protection were some of the subjects covered in this manner.

JOHNSTOWN . . . At this joint meeting with local chapters of the Pennsylvania Society of Professional Engineers and the American Institute of Electrical Engineers, Garland M. Branch, Liaison Scientist in Electron Physics at the General Electric Research Laboratory, was guest speaker. Speaking on February 24th, he discussed various methods of converting heat into electricity on which General Electric is experimenting. Also covered by Dr. Branch was usage of fossil fuels and life expectancy of their supply based on present rate of increase in population. He stated that we are wasting these fuels through inefficiency in present-day methods of burning coal and transforming the heat into electricity by use of turbines.

MISSISSIPPI . . . Program for the February meeting was a tour of the McQuay, Inc., Grenada (Miss.) Plant. Various manufacturing processes, including forming parts, assembly, welding, fastening, testing and packing, were demonstrated and the plant manager, superintendent and personnel manager answered questions posed by Chapter members about the plant.

BATON ROUGE . . . Centrifugal refrigeration was the subject of a talk by R. L. Bernhard, Vice President of American-Standard's Industrial Div, guest speaker at the February 17th meeting.

FLORIDA WEST COAST . . . Various types of bids and how each affects different phases of the job, practical methods of proposing substitutions, preventing submission of proposals that do not comply with the specifications and determination of compliance with the specifications were among aspects of the construction field discussed by a panel comprised of Frank McLane, architect; Charles T. Healy, mechanical engineer; Flake Chamberliss, general contractor; Richard Steinholm, mechanical contractor; and Richard Peck, equipment supplier. Questions under consideration included: To what extent is a general contractor responsible for the liabilities of a sub-contractor? Whose responsibility is enforcement of prompt payment to sub-contractors and how can this be controlled? How can final balancing, adjusting, trimming and general finishing of the mechanical trades be improved?

MICHIGAN . . . Holding their February meeting at the new Reynolds Metals Company Building in Detroit, members of this Chapter were shown through the building and heard a brief address on the research and development of new aluminum products, given by John Finegan of Reynolds Metals.

Following this, representatives of Minoru-Yamasaki & Associates, the architects for the building, described the architectural and mechanical aspects of design. Principal speaker was Cass S. Wadowski, Executive Vice President.

MEMPHIS . . . Members of a panel discussion on "Freeze Protection" held at the February 15th meeting included Dan Roop, Hospital Consultant, as Moderator; Turk Humphrey and Phillip Hall, Consulting Engineers; Carl Fischer, Contractor; and C. A. Carson, Building Manager.

Reasons for coil freeze-up discussed were: air lock in the coil when several units are served by one pump, vacuum in steam coils preventing drainage of condensate, water velocity too low and coil face velocity too high, low air flow over direct expansion coil causing freezing of down-stream water coils, manual outside air dampers left open and air leakage through closed dampers.

LOUISVILLE . . . Speaking on the "Influence of Connections on Fan Performance," William E. Tracy of Westinghouse Electric Corporation went further than discussion of fan theory, illustrating his points with actual equipment.

Used by him was a small centrifugal blower connected to a straight run of pipe with an adjustable damper. A large illuminated set of draft gauges

CHAPTER MEETING DATES

	Apr.	May	June
Alamo	26	24	28
Arkansas	20	18	15
Atlanta	11	—	—
Austin	21	19	16
Baltimore	7	5	—
Baton Rouge	14	19	—
Boston	26	17	—
British Columbia	13	11	—
Central Arizona	4	2	—
Central Indiana	12	10	—
Central Michigan	12	10	14
Central New York	13	11	—
Central Oklahoma	11	9	—
Central Pennsylvania	13	—	—
Cincinnati	6	—	—
Cleveland	11	9	—
Columbus	18	16	—
Dallas	18	16	20
Dayton	6	—	—
El Paso	11	9	—
Evansville	5	3	4
Florida West Coast	19	17	21
Fort Worth	20	18	15
Golden Gate	7	5	2
Hampton Roads	5	—	10
Houston	15	20	17
Illinois	11	9	—
Illinois-Iowa	18	16	—
Inland Empire	12	10	14
Iowa	12	10	—
Jacksonville	1	3	7
Johnstown	12	10	—
Kansas City	4	2	—
La Ville de Quebec	11	9	13
Long Island	11	9	13
Louisville	11	9	—
Manitoba	28	—	—
Memphis	17	15	—
Michigan	18	24	—

registered pressure rise, air volume delivery and fan power. Using a set of removable duct connections, speaker Tracy was able to demonstrate the effect of varying inlet and outlet conditions. It was shown that delivery pressure is high when delivered flow rate and power required are low. As the volume delivered increases, pressure drops and the power required increases. Also demonstrated was that the resistance to flow of a duct system connected to a fan varies parabolically with respect to air volume. Where the volume-pressure (resistance) curve of the system crosses the fan volume-pressure curve is the point the engineer must estimate when he designs an air moving system. Tracy concluded by citing examples where properly matching the duct system and fan for optimum installed efficiencies resulted in operating economies.

SOUTH FLORIDA . . . Demonstrating the operation of sound survey materials, sound level materials and active band noise analyzers, John C. Held of General Radio Company spoke at the February 9th meeting on "Product Noise – its measurement, rating and control."

NEW YORK . . . Packaging of larger air conditioning and refrigeration machinery is a trend which has increased steadily in recent years. Motivated by lower installed cost of equipment as well as by greater reliability of performance of packaged systems, this new approach has been assisted by development of high tensile alloys and improved lubrication systems, both important factors in larger packaged equipment.

As contrasted with the open type compressor, the hermetic unit is cited as presenting somewhat greater problems in installation, care and maintenance. External factors influence greatly the performance and longevity of this type of equipment. Exploring the application of large hermetic reciprocating compressors, John L. Roth and George Finck of Dunham-Bush, Inc., were guest speakers at the February 23rd meeting.

PITTSBURGH . . . Assisted by Elliot Godes, Assistant Director of Research of Anemostat Corporation, Franz Kurth of the same organization spoke on "Economic Aspects of High Velocity Designs" at the February 15th meeting. Starting his talk with a basic definition of high velocity, indicating that this meant air flow at more than 3000 fpm, he stated that combination of a dual duct and high velocity air system has many advantages over previous systems. Speaker Kurth presented an economic comparison of the dual duct high velocity system with induction units, fan coil units and mixing boxes. Godes followed this with an explanation of the importance of proper duct design and how this can be accomplished.

CLEVELAND . . . Meeting February 8th, members of this Chapter heard a three-man panel discuss three different aspects of refrigeration and air conditioning. Jack Barton of Feldman Company spoke on low temperature refrigeration, presenting an analysis of Compound vs Cascade Systems. Problems in frosting of low temperature coils and several methods of defrosting were covered.

Discussing problems in design of refrigeration systems for walk-in coolers and freezers, Hugo Smith of Avery Engineering Company, second member of the panel, presented several short form methods for estimating the cooling load.

George Nachman, President of Spohn Heating and Ventilating Company, then spoke on "Comfort Air Conditioning in Apartment Houses." Pointed out in his talk was the need to make owners, institutions and others aware of the advantages of air conditioning.

Concluded were the necessity for educating the public for higher quality systems, improvement of equipment and more efficient installation methods.

AUSTIN . . . Discussing the new City of Austin Air Conditioning Code, effective February 1st, at a recent meeting were Joseph Boyer, Heating Section; William Brydson, Air Conditioning Section; Richard Jordan, City Administration and its enforcement; and B. Segall, Moderator.

WESTERN MICHIGAN . . . Stressing the importance of correct installation in minimizing service, Lee Miles of Mueller Climatrol spoke on air conditioning service at a recent meeting, first discussing the necessity for sufficient air in both cooling and heat pump applications. Also receiving attention were electrical power, control circuits, system cleanliness and dryness and the instruments necessary for satisfactory air conditioning service.

At the February meeting, speaker K. E. Robinson of General Motors Corporation, after showing slides of psychrometric charts with a brief description of their use, exhibited drawings of a typical industrial ventilation problem and its solution. Utilized in

	Apr.	May	June
Middle Tennessee	12	10	—
Minnesota	11	9	—
Mississippi	25	23	27
Mobile	21	26	23
Montreal	19	16	13
National Capital	5	—	—
Nebraska	12	10	—
New Mexico	19	17	21
New Orleans	19	17	—
New York	26	24	—
Niagara Peninsula	7	2	—
North Alabama	—	—	—
North Jersey	7	5	2
North Piedmont	—	—	—
Northeastern New York	—	17	—
Northeastern Oklahoma	18	16	—
Northern Alberta	20	18	9
Northern Connecticut	14	12	—
Northern Ohio	—	—	—
Ontario	—	—	—
Oregon	14	12	16
Ottawa Valley	—	—	—
Panama & Canal Zone	12	10	14
Philadelphia	14	12	—
Pittsburgh	18	—	—
Puget Sound	12	10	—
Rhode Island	20	18	—
Richmond	4	2	—
Rochester	6	—	—
Rocky Mountain	8	—	—
Sacramento Valley	6	4	1
St. Louis	25	23	—
San Diego	12	10	14
San Joaquin	19	17	21
Savannah	19	17	14
Shreveport	21	19	16
South Carolina	18	16	20
South Florida	12	10	14
South Piedmont	—	—	—
Southern Alberta	19	17	—
Southern California	11	9	13
Southern Connecticut	12	10	14
Toledo	4	2	—
Tucson	—	—	—
Utah	15	21	17
West Texas	25	23	27
Western Massachusetts	21	16	—
Western Michigan	11	—	—
Wichita	19	17	—
Wisconsin	18	16	—

this cited installation were discharge grilles ten ft above the floor, with discharge air velocities ranging from 1600 to 4000 fpm.

BRITISH COLUMBIA . . . Citing an existing installation, Steve Slinn, a Chapter member, spoke on the "Air Conditioning System in the Oak Ridge Shopping Center" at the February 10th meeting.

Illustrating his talk with drawings of flow diagrams and general system layouts, he traced some of the design problems which had been encountered and outlined basic details of the system.

ARKANSAS . . . Illustration of his discussion with slides and a small scale working model demonstrating automatic defrost highlighted the talk of Robert C. Elliot of Dunham-Bush, "Application of Commercial Refrigeration and Automatic Defrost Methods."

RHODE ISLAND . . . Covered in a film on natural gas, shown at a recent meeting by Mark Pasqualletti, Heating Engineer of Providence Gas Company, was procedure involved in location of a gas well; building the installation, with its network of piping underground; and maintenance. Speaker Pasqualletti described the growth of his company from the days of gaslight to the present.

SOUTHERN CALIFORNIA . . . Topic of a panel discussion at the February meeting was "Refrigerant Piping – an Art or a Science?" Speaking were W. E. Gregory, engineer for F. B. Gardner Company; Edward Haynie, engineer for Air Conditioning Company; and E. H. Gebhardt, engineer for Western Air and Refrigeration Company. William L. Holladay was Moderator.

Design of suction lines is of prime importance, according to Engineer Gregory, because of the costly damage resulting from liquid slugs reaching the compressor. Two things with which engineers designing suction lines are most often concerned, he stated, are velocity in the line and risers. Speaker Gregory contends that 750 fpm in horizontal lines and 1500 fpm in vertical lines are good design criteria when considering velocity.

Discussing hot gas lines for single reciprocating compressor installations using Refrigerant 22, speaker Haynie cited three items to be considered: pressure drop, prevention of condensation of the gas and its flowing back to the compressor and sizing of the hot gas line for varying capacities. High pressure drop and excessive noise often result from sizing the line smaller than is required. Items mentioned were that a hot gas line loop at the compressor is necessary to prevent liquid return, a muffler should never be installed in a vertical discharge line riser and a discharge line oil separator or a hot gas velocity riser is not necessary for operation at low capacity.

Speaker Gebhardt commented on system design in general. Experience indicates, he stated, that liquid lines are generally oversized; economy measures should be undertaken here, not in suction line sizing. For multiple compressor installations, two equalizing lines should be used, one for crank case equalization and one for oil return and level. One line at crank case oil level should not be used for both jobs. If possible, a separate circuit should be installed for each compressor by splitting evaporators, condensers and such and matching the compressor to the system.

ROCKY MOUNTAIN . . . Both with Martin Company, Elmer Davis and Arthur Grossman served as guest speakers at the February 10th meeting, speaking on development of the air conditioning system for the Titan missile. A film picturing this development was shown at the conclusion of their talk.

NIAGARA PENINSULA . . . W. L. Algie served as Moderator of a panel which met at the February 2nd meeting to discuss problems arising in the design of an air conditioning system. Comprising the panel were Peter Bell of W. R. Souterr & Associates, architect; Jack Elliott of Goodram Brothers, contractor; Donald Harper of Trane Company, manufacturer; and William McDonald of H. H. Angus & Associates, Consulting Engineer.

Charter Meeting of this Chapter, 89th in the Society, was held on March 1st in Hamilton, Ontario. National Society representatives included Walter A. Grant, Robert H. Tull and John Everetts, Jr., First, Second and Third Vice Presidents, respectively; John H. Fox, Director-at-Large; D. L. Angus, Region II Director; William G. Hole, past Regional Director, and F. W. Hofmann, Assistant Secretary – Membership.

Principal speaker was Vice President Grant, who discussed the role of the chapter in Society operations and presented the Charter. Past-Director Hole spoke on the history of Canadian chapters. Presentation of an engraved gavel, a gift of Middle Tennessee Chapter, was made by Vice President Tull to Chapter President Algie and Assistant Secretary Hofmann presented a record book to William L. Carr, Chapter Secretary.

Officers of the Chapter are: W. Lloyd Algie, President; Gary E. Elliott, First Vice President; William M. Carr, Secretary; R. C. Brace, Treasurer; and L. Santesy and John H. Mitchell, Board of Governors.

NEW ORLEANS . . . Covering in his presentation the history, application, selection and special considerations required of centrifugal refrigerating machines, R. L. Bernhard, Vice President of American-Standard's Industrial Div, spoke at the February 16th meeting. He elaborated on the new possibilities of centrifugals with higher speed prime movers.

WEST TEXAS . . . Need for revision of the Lubbock City Code for installation of heating and air conditioning systems was discussed at the February meeting, with no action to be taken pending election of new City Commissioners.

Principles of air distribution within rooms were discussed by Harold E. Straub, Chief Inspection Engineer for Titus Manufacturing Corporation, with

slides serving to illustrate his points. Speaker Straub's talk was based on experimental work conducted by him at the University of Illinois, on air distribution and grille location for optimum effect with both heated and cooled air.

PHILADELPHIA . . . Reporting at a meeting of the Board of Governors held February 11th, Robert Spence announced that topics chosen for a Refrigeration Seminar, to be held March 26th, include: fundamentals of refrigeration, Melvin J. Wind; DX systems; packaged water chillers (DX); chilled water systems; aluminum and copper brazing; General Electric leak detectors; thermocouples; and wet bulb indicator vs vacuum gauge, Walter Statts.

Earle K. Wagner, in his capacity as Region III Director, reported on the Dallas meeting, with emphasis on items affecting this Chapter. Chief among these was a meeting of the Executive Committee to be held in New York, at which such matters as new Chapter budgets and the revised dues structure would be discussed.

NEW MEXICO . . . A. D. Ford, Professor of Mechanical Engineering at the University of New Mexico and Frank Bridgers of Bridgers & Paxton, Consulting Engineers, presented a forum with senior students from the University at the February 16th meeting.

GOLDEN GATE . . . Hosts at a tour of the air conditioning system of the Crown-Zellerbach Building, held February 4th, were Thomas W. Woods, Building Superintendent; Alex Boome, Consulting Engineer; Frayne Fenny and Charles Lambert.

RHODE ISLAND . . . Heat pumps were the subject of discussion at the February meeting, with John K. Shannahan of American Electric Power Service Corporation and Raymond McCready of Carrier Corporation speaking on the future of this equipment and Frank C. Caulfield of Narragansett Electric Company describing preparations made in the distribution system of the company to handle the new load brought about by installation of heat pumps.

MONTREAL . . . At the February 15th meeting, William G. Hole, past Region II Director, announced the chartering of a new Chapter in Hamilton, Ontario.

E. G. Hansen of J. O. Ross Engineering was guest speaker, discussing the U. S. Air Force Academy at Colorado Springs. This project, covering a large area at great altitude differences, is heated by a high temperature hot water system, with individual gas-fired heating in dwelling units. Steam distribution was not chosen for the system because of long runs and the differences in altitude, while individual boiler plants would have presented a maintenance problem. Slides showing the boiler house, mains and tunnels highlighted speaker Hansen's discussion.

CENTRAL OKLAHOMA . . . David M. Dart, speaking on the merits of air-cooled condensers at a recent meeting, expressed the contention that users prefer this type of equipment to water-cooled. Various methods of head pressure control in use were discussed by him.

February speaker Phillip Bennett of Kerr-McGee Oil Industries and a Director of the Frontiers of Science Foundation delivered his talk on the organization and purpose of the Foundation. First major project was a semi-centennial exhibit of atomic equipment for peaceful purposes in 1955, followed by work on the International Geophysical Year, symposiums and an exchange of teachers between Oklahoma City University and Massachusetts Institute of Technology.

DALLAS . . . Various types of air conditioning, with emphasis on those using chilled and warm water for distribution of conditioned air, were the subject of a talk presented at the February 15th meeting by Clyde A. McKeemen, Director and Supervisor of the Heating and Cooling School, Plumbing and Heating Div, American Radiator & Standard Sanitary Corporation.

HOUSTON . . . Slides demonstrating basic concepts of insulation in refrigeration and air conditioning systems were used to illustrate an address, "Insulation, Concepts and Practices," by R. W. Theobald, Customer Service Engineer for Dow Chemical Company, speaker at the February meeting.

ROCHESTER . . . George Wheeler, Chief Engineer of Tenney Engineering Company, discussed the development of cascade and compound refrigeration systems for ultra-low temperatures, at a meeting held March 2nd. With the aid of slides, he explained the difference between compounding and cascading and the use of Refrigerants 13 and 22 to get evaporator temperatures of −110 F. Photographs and discussion of existing installations concluded his talk.

WISCONSIN . . . Divided into three main topics — selection and ordering, installation, and service — the topic under discussion at the February meeting was "The Manufacturer's Point of View." Speaker Felix Veliath stressed, under the first heading, that loads should be calculated accurately, all load circumstances should be considered and orders should include every detail possible. Under "Installation," he emphasized following the manufacturer's instructions and wiring diagrams exactly, suggesting having a factory man on the job. "Service" included mention of contracts, preventive maintenance and stocking of replacement parts.

CHAPTERS REGIONAL COMMITTEE
MEETINGS AHEAD

REGION II, Northern Alberta Chapter (Edmonton), June 8
REGION III, Richmond Chapter (Williamsburg), Oct. 22-23
REGION VIII, Alamo Chapter (San Antonio), May 9
REGION IX, Utah Chapter (Salt Lake City), May 4
REGION X, San Joaquin Chapter (Fresno), May 6-7

Candidates for ASHRAE Membership

Following is a list of 129 candidates for membership or advancement in membership grade. Members are requested to assume their full share of responsibility in the acceptance of these candidates for membership by advising the Executive Secretary on or before April 30, 1960 of any whose eligibility for membership is questioned. Unless such objection is made these candidates will be voted by the Board of Directors.

Note: * Advancement † Reinstatement

REGION I

Connecticut

LYONS, S. S., Sales Mgr., Nash Engineering Co., South Norwalk.
ROBBIN, H. M., Sales Engr., Trane Co., West Hartford.
THOMPSON, T. G., Proj. Engr., Dunham-Bush, Inc., West Hartford.

Massachusetts

JARDIN, ADOLPH,* Design Engr., Francis Associates, Marion.
MATHER, C. T.,* Engr., F. R. Steam & Gas Pipe Co., Fall River.
MCKONE, H. J., Proj. Engr., Hayden, Harding & Buchanan, Inc., Boston.

New York

BARNES, R. E., Tech. Dir., Perlite Institute, Inc., New York.
BIANCULLI, V. A.,† Principal, Syska & Hennessy, New York.
BLATMAN, SEYMOUR,† Sales Engr., Dunham-Bush, Inc., New York.
CINO, S. A., Estimator, Charles Hartman Co., Brooklyn.
CLINTON, D. J., Engrg. Estimator, Hi-Press Air Conditioning of America, New York.
FOOTE, C. F., Engr. & Field Supvsr., Temperature Design Corp., New York.
LEICHTER, M. M., Engr. & Field Supvsr., Temperature Design Corp., New York.
LEVANDER, S. S., Assoc., Frank A. Kristal Associates, Inc., New York.
PERKINS, CHARLES, Design & Sales Engr., Slant/Fin Radiator Corp., Richmond Hill.
QUINN, J. F., Proj. Engr., Voorhees Walker Smith Smith & Haines, New York.
RODSTROM, C. M., Proj. Engr., Carrier International Ltd., New York.
ROGERS, RICHARD D., Asst. Mgr. & Engr., Carrier Corp., Syracuse.
SCHLITT, E. H.,† Chief Engr., Hudik Ross Co., New York.
STENGER, H. G., Engr., Carrier Corp., Syracuse.
TIFFT, R. L., Other Engr., Carrier Corp., Syracuse.
WEIKART, H. N., Assoc. Engr., International Business Machines Corp., Kingston.
WILTS, R. C., Sales Mgr., American Standard - Industrial Div., New York.
WOZNICK, M. M., Plbg. Designer, Voorhees Walker Smith Smith & Haines, New York.

Rhode Island

KAMINSKI, JOHN, Engr., J. D. Guillemette & Assoc., Providence.

REGION II

Canada

ARMSTRONG, J. E., Sales Engr., Sarco Canada Ltd., Toronto, Ont.
CRAWFORD, R. T., Dist. Mgr., Canadian Ice Machine Co. Ltd., Calgary, Alta.
GALBRAITH, J. C.,* Com. Sales Supvsr., Frigidaire Products of Canada Ltd., Scarborough, Ont.
JONASSON, K. H., Design Engr., O. G. Moffat, Cons. Engr., Hamilton, Ont.
MCARTHUR, R. B., Design Engr., Toronto Board of Education, Toronto, Ont.
SIGURDSON, D. B., Proj. Engr., Green, Blankstein & Russell Assocs., Winnipeg, Man.
THOMAS, J. K., Estimator, A. S. Leitch, Scarborough, Ont.
TOMKO, JOHN, Sales Engr., Dunham-Bush (Canada) Ltd., Toronto, Ont.
WARK, I. A., Sales Engr., Sarco Canada Ltd., Toronto, Ont.

REGION III

District of Columbia

BUNKER, J. B., JR., Engr., United Clay Products Co., Washington.
ECKERT, R. S., Supvsg. Mech. Engr., Design & Constr. Div., P.B.S., Gen. Serv. Adm., Reg. 3, Washington.
MAERLENDER, W. H.,† Sales Engr., United Clay Products Co., Washington.
RICHMOND, J. W., Chief Engr., United Clay Products Co., Washington.

Maryland

BALDWIN, A. W.,* Supervisory Gen. Engr., U. S. Naval Ordnance Laboratory, Silver Springs.
WATSON, A. B.,† Design Engr., Western Electric Co., Baltimore.

Pennsylvania

DETWILER, D. W., Sales Engr., Detroit Controls Div., American-Standard, Philadelphia.
HAUFLER, G. J., Proj. Engr., John J. Nesbitt, Inc., Philadelphia.
HEIM, R. G., Mech. Engr., Gilbert Associates, Inc., Reading.
MARCUS, A. I., Mgr. Mech. Dept., Limbach Co., Pittsburgh.
NOBLE, H. W., Service & Maint. Repr., Delaware Valley-York, Inc., Philadelphia.
POWELL, G. W. III,* Mech. Engr., United Engineers & Constructors, Inc., Philadelphia.
SANDERS, W. A., Partner & Owner, Sanders & Thomas, Inc., Pottstown.

REGION IV

Florida

GOODMAN, W. L., Supt., Charge of Construction, Dublin Co., Miami.
LOGSDON, H. G., Design & Supervision, A-C Htg. Refrig., Tampa.
MANRIQUE, D. R., Pres., Quint Corp., Tampa.
STILLSON, W. W., Sales Engr., Barber-Colman Co., Jacksonville.
THOMPSON, J. B., Repr., Vollers Heating & Air-Conditioning, Jacksonville.
WILLIAMS, C. L., A-C. & Refr. Service & Installation, Board of County Comm., Bartow.

Georgia

ENDSLEY, J. W., Engr., Manning Co., Atlanta.
LITTLE, F. R., Design Supvsr., Atlanta Gas Light Co., Atlanta.
NOTTINGHAM, G. M., JR., Cons. Engr., Macon.
THOMPSON, J. W., Mech. Design Engr., Atlanta General Depot, Forest Park.

REGION V

Indiana

BUTKUS, J. J., Sales Engr., General Electric Co., Evansville.
PASSTY, B. G., Dvlpt. Engr., Arkla Air Conditioning Corp., Evansville.

Ohio

NACHMAN, D. K., Mech. Engr., Spohn Heating & Ventilating Co., Cleveland.
SIMMONDS, H. R., Sales Repr., American Brass Co., Columbus.

REGION VI

Illinois

BAUGH, M. R., Mgr. Supply Div., Champion Furnace Pipe Co., Peoria.
CONRAD, R. M., JR., Mgr., Beling Engineering Consultants, Peoria.
DUVALL, C. E., Secy.-Treas., Lee Wagener Co., Peoria.
HOLLOMAN, H. J., Chief Mech. Engr., Ragnar Benson Inc., Chicago.

HUNZEKER, M. E., Sales Engr., Trane Company, Peoria.
LEVY, M. A., Partner, Consulting Associates, Chicago.
LONQUIST, B. A., Proj. Engr., Schmidt, Garden & Erikson, Chicago.
NELSON, D. W., Br. Mgr., Powers Regulator Co., Peoria Heights.
TOOKER, D. R., Design Engr., Schmidt, Garden & Erikson, Chicago.
WILLETTS, J. A., Repr., American-Standard, Industrial Div., Peoria.

Michigan

DENNY, R. J., Proj. Engr., American-Standard, Industrial Div., Detroit.
GRAY, W. G., Sales & Appl. Engr., D. T. Randall & Co., Grand Rapids.
WINTERS, G. G., Tech. Repr., Union Carbide Chemicals Co., Detroit.

Minnesota

HERMAN, N. B.,* Pres., Allied Store Equipment Co., Minneapolis.
HUCK, W. V., Research Supvsr., Minnesota Mining & Mfg. Co., St. Paul.

Wisconsin

BARTOSZEK, A. C., Sr. Lab. Tech., Johnson Service Co., Milwaukee.
SKALICKY, L. V.,* Chief Engr., NorLake, Inc., Hudson.

REGION VII

Alabama

BENDALL, R. L., Sales Engr., Johnson Service Co., Birmingham.

Louisiana

BODEN, W. W., JR., Repr., Owens-Corning Fiberglas Corp., New Orleans.

Missouri

LEHLEITNER, R. S., Sales Engr., Jackes-Evans Manufacturing Co., St. Louis.
MILLER, J. N., Chief Engr., Jackes-Evans Manufacturing Co., St. Louis.
REIGLER, HARTMAN, Chief Mech. Engr., General Services Adm. PBS, D & C Div., Kansas City.

Tennessee

GRACE, M. F., Dist. Sales Mgr., Robertshaw-Fulton Controls Co., Chattanooga.
HARDY, O. R.,* Head Const. & Maint., National Toddlehouse Corp., Memphis.
TACKER, J. J., Design Engr., American & Southern Corp., Nashville.
WEBB, T. A., Sr. Sales Engr., Minneapolis-Honeywell Regulator Co., Nashville.

REGION VIII

Oklahoma

DEHART, E. L.,† Owner-Mgr., DeHart Air Conditioning, Refrigeration & Heating Co., Chickasha.

Texas

CRUMP, R. L., Sales Engr., Carrier-Bock Co., Dallas.
FEEHERY, L. T., Sales & Appl. Engr., Straus-Frank Co., Houston.
MARLOW, RAYMOND., Design Engr., Texas Instruments, Inc., Dallas.
THEIMER, G. M.,† Dist. Htg. & A-C. Sales Engr., Crane Co., Dallas.

REGION IX

Colorado

KONKEL, J. H., Cons. Engr., Denver.

Montana

KLABOE, JOHN, Design Engr., Sullivan Valve & Engineering Co., Butte.

New Mexico

FRIGGENS, R. P., Com. Sales Engr., Minneapolis - Honeywell Regulator Co., Albuquerque.

REGION X

British Columbia

CHARLTON, C. M., Exec. Vice-Pres., Vanco Products Ltd., Vancouver.
NEIFER, E. F., Pres., Neifer Installations Ltd., Vancouver.
PATRICK, B. S., Sales Engr., Eric Ackland & Assocs. Ltd., Vancouver.

California

BARTON, R. G., Com. Sales Mgr., Minneapolis-Honeywell Regulator Co., Sacramento.
DEHRER, G. L., Draftsman/Designer, Eagleson Engineers, San Francisco.
ETTINGHAUSEN, LARRY, Pres., Special Service Supply Co., San Diego.
HAYES, J. G., Research, Prod. Dvlpt. & Sales Engr., Owens-Corning Fiberglas Corp., Santa Clara.
OLBRIGHT, C. R., Sales Mgr., Valley Refrig. Supply, San Bernardino.
OLBRIGHT, G. M., Mgr., Valley Refrig. Supply, San Bernardino.
REECE, A. M., Supvsr. Mech. Engr., U. S. Army Engineering District-Okinawa, San Francisco.
TUCK, R. H., Sales Engr., J. L. Myers Co., San Francisco.
WEBB, F. L., Mech. Engr., Radiant Heat & Cooling Engrs., W. Los Angeles.

Washington

LIDDLE, D. A., Mgr., Safeway Stores, Const. Dept., Seattle.
MICKELSEN, M. R., Designer, Lyle E. Marque & Assoc., Spokane.
PLUMMER, B. G., Designer, Lyle E. Marque & Assoc., Spokane.

Alaska

HOCKINSON, W. L., Installation Mgr., Minneapolis - Honeywell Regulator Co., Anchorage.
ROMANKIW, M. A., Mech. Engr., Inlet Mechanical Inc., Anchorage.

Canal Zone

PLUMER, A. H., Refr. & A-C. Service Man, Panama Canal Co., Mt. Hope.

FOREIGN

Argentine

ALVAREDO, D. O., Cons. Engr., Buenos Aires.
DUJOVNE, ENRIQUE, Asst. Factory Mgr., Aster, Rosario.

Australia

CLEMENTS, R. F., Installation, J. Wildridge & Sinclair, Pty., Ltd., Sydney.
KNOX, A. G., Supvsg. Engr., F. J. Walker Ltd., Sydney, New South Wales.

England

HOBBS, K. G.,* Exec. Engr., Gratte Bros. Ltd., London.
HUSBAND, R. H., Chief Engr., Beecham Group Ltd., Brentford, Midd.
TUCKER, T. B., Exec. Assoc. Partner, A. F. Myers & Partner, London.

Greece

CONSTANTINOPOULOS, P. G., Chief Design Engr., Electrotechnical Co., Athens.

Hongkong

TAO, EDWIN, Chief Engr. & Mgr., American Engineering Corp.

Italy

CLERICI, C. R., Cons. Engr., Libero Professionista, Milan.
MERLO, SIRO, Engr., G. De Micheli, Milan.
PIERLUIGI, ANTONINI, Mgr., Edoardo Lossa Co., Milan.
SAIBENE, ALBERTO, Gen. Mgr., Jucker Societa per Azioni, Milan.

STUDENTS

BRADFIELD, K. R., General Motors Institute, Flint, Mich.
CASSIMATIS, N. J., City College of New York, New York.
KIL, D. Y., University of Washington, Seattle.

NEXT MONTH ——

Previews, abstracts and program for the 67th Annual Meeting of ASHRAE at Vancouver, B.C. June 13-15. There will be four technical sessions, three symposiums and several forums. Topics in review will include absorption air conditioning, refrigerants, thermoelectric engineering, heating, and domestic and commercial refrigeration.

BULLETINS

(*Continued from page* 77)

ings. Engineering data is given on spacer couplings with drop-center sleeves and on use of Sure-Flex couplings with a floating shaft to connect two shafts that cannot be brought close enough together to be connected by a single coupling.
T. B. Wood's Sons Company, Chambersburg, Pa.

Electric Heating Equipment. Heat pumps providing automatic zone heating and cooling, built-in wall heaters in a variety of sizes, radiant heat cable, baseboard heaters and infra-red radiant and convectional ceiling mounted heaters, recessed and surface mounted, are equipment covered in four-page Bulletin X9268A.
Emerson Electric Manufacturing Company, 8100 Florissant Ave., St. Louis 36, Mo.

Weld Fastener Catalog. Extensive technical data and welding information incorporated in 52-page Catalog 60 is in addition to dimensional information on stock weld nuts, weld screws, special purpose weld parts and leg levelers, electrode data, designs and weld setups for welding individual parts and illustrations and descriptions of typical applications. Designed as a combination catalog and welding manual, the booklet also contains an engineering section with detailed explanations of how to gain optimum welds under various conditions and suggestions on how to lower costs and increase the number of welds per hr through more efficient welding practices.
Ohio Nut & Bolt Company, 33 First Ave., Berea, Ohio.

Liquid Level Controls. Included in this four-page condensed catalog are: an explanation of the principle of operation, detailing of both two and three-pole controls and enclosures, information on Multiple Pump Controls and Special Control Panels and a run-down on electrode fittings and electrodes.
Charles F. Warrick Company, 1964 W. Eleven Mile Rd., Berkley, Mich.

Odor Control. "Sanitaire" odor control units provide odor control in areas ranging from a six room house to a convention hall. Utilizing Westinghouse Sterilamps especially designed for odor control application, these units come in three models, adaptable

(*Continued on page* 96)

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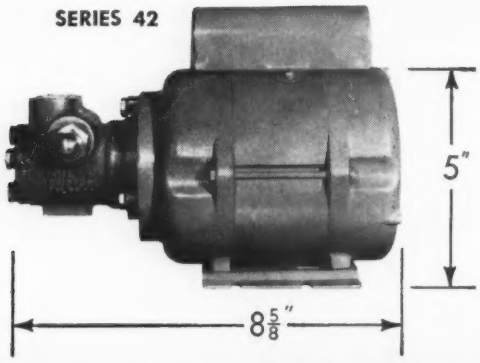
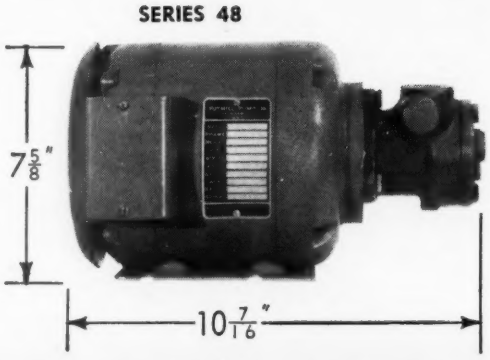
COPPER PIPE
COPPER DRAINAGE TUBE (DWV)

SCOVILL MANUFACTURING COMPANY • COPPER TUBE MILL PRODUCTS, WATERBURY 20, CONN.

105C60





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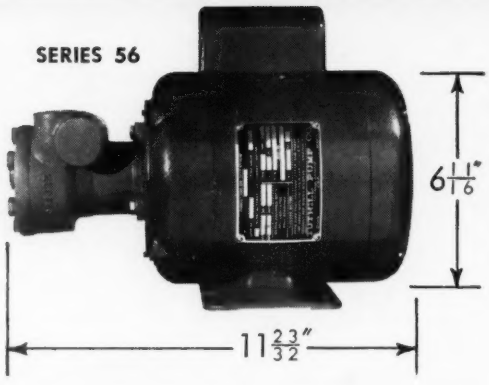

Tuthill close-coupled pumps and motor combinations are especially designed for applications where space is at a premium. Their compactness simplifies assembly operations and lowers production costs. Elimination of couplings, bases and adapters results in significant savings . . . and reduced weight means lower shipping costs.

Tuthill offers a complete selection of units with capacities up to 50 GPM for pressures to 500 PSI. A wide variety of special options is also available. Three standard units are pictured above.

Immediately available from stock

The series 42 units measure only 5"x8 5/8". Their total enclosed ballbearing motors are normally supplied with ratings from 1/12 to 1/6 HP while the pump units have capacities of 20 to 45 GPH at 200 PSI.

Series 48 units, measuring 7 5/8"x10 7/16", are normally supplied with totally enclosed, fan-cooled motors of either split phase, capacitor, or 3 phase construction . . . with ratings from 1/4 to 1/2 HP. They can be supplied with pumps with capacities from 20 GPH to 360 GPH at 200 PSI.

Series 56 units measure 6 11/16"x11 23/32", and are offered in a complete range of motors varying from 1/4 to 1 HP. These can be coupled with pumps with capacities from 20 to 360 GPH at 200 PSI.

Although motors are normally furnished for 1725 RPM they are also available for 3450 and 1140 RPM. Explosion proof construction and double shaft extensions on motors are also furnished in series 48 & 56. Built-in relief valves are optional on all five pump sizes.

Special construction for OEM applications

The units shown plus others in Tuthill's line are immediately available without any quantity restrictions whatsoever.

For those original equipment applications involving substantial quantities, Tuthill's engineers can design and build a POWERMITE . . . an exclusive Tuthill design in which pump and motor are combined in one unit which takes up no more space and weighs no more than a standard electric motor. As an example of the compactness possible a Tuthill POWERMITE now being supplied for a hydraulic application measures only 4 3/4"x8 1/16", yet has a capacity of 16 GPH at 350 PSI.

Tuthill's field engineers will be happy to provide details on the complete Tuthill close-coupled line and its application to your particular problem. If you are trying to fit a pump and a motor into a tight space you should talk to them soon. Call today.

Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1/3 to 200 GPM; for pressure to 300 PSI; speeds to 3600 RPM.

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969 East 95th Street, Chicago 19, Illinois

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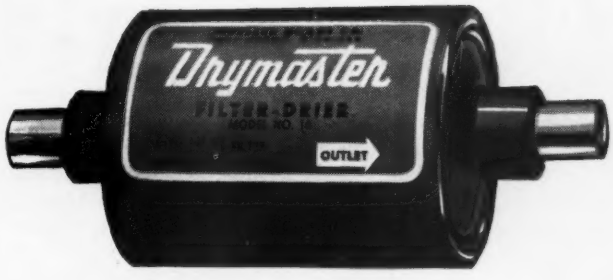
with balanced drying and filtering is the best engineered filter-drier you can buy today!



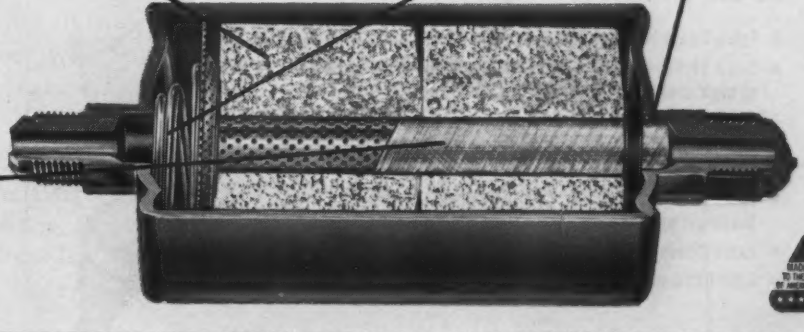
Drymaster Filter-Driers meet the most exacting needs of today's modern refrigeration system. Engineered and rated in every respect in accordance with ARI Standard 710-58, Drymaster does *both* filtering and drying perfectly . . . gives guaranteed balanced performance. To provide the versatility to meet the demands of every installation, Drymasters are available in a wide range of types, capacities and sizes with either male, female flare or copper solder-type end connections for easy installation . . . Drymasters are also available in combination with the Sightmaster Liquid Indicator.

Drymaster is engineered for today's modern refrigeration systems

HI-FI FILTER BLOCK DESICCANT—fully activated, pressure-molded briquette removes ALL moisture, acid, sludge and micron-size foreign particles. Unequalled in moisture absorbing capacity; surface and internal depth filtering is unsurpassed by comparable sized driers.

SHOCK-PROOF ASSEMBLY—Filter tube, alignment hub, conical spring and spacer at outlet end form cushion suspension for internal parts; heavy-welded body construction makes Drymaster Shock-Proof.

FILTER TUBE—perforated tube with monel screen makes a doubly effective safeguard against dirt and sludge.



For sizes, complete information and specification on Drymaster Filter-Driers, send for new bulletin. Just released.

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Exclusive Canadian Representative for Mueller Brass Co. Air Conditioning and Refrigeration Products.

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BULLETINS

(*Continued from page* 92)

to home installation, packaged ac units or commercial (over ten ton) ac units. Information is presented in a six-page folder.
Atlantic Ultraviolet Company, 24-10 40th Ave., Long Island City 1, N. Y.

Thermal Insulation. Containing product descriptions covering chemical, physical and structural properties, in addition to shipping and handling notes and suggestions as to use, this bulletin has as its subject Santocel A, a silica aerogel used for thermal insulation.
Inorganic Chemicals Div, Monsanto Chemical Company, 800 N. Lindbergh Blvd., St. Louis 66, Mo.

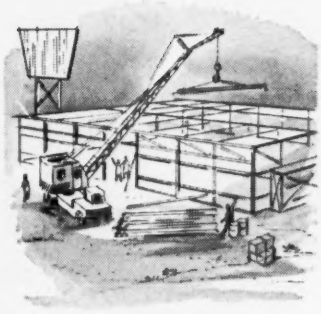
Bearing Units. In addition to load rating and comparison charts, 20-page Catalog BU-103-A contains detailed specifications on a wide variety of bearing units, including: pillow blocks with sealed bearings in low and high heights, four-hole flange units with sealed bearings to 2-7/16 in., two-hole flange units with sealed bearings to 2-3/16 in., pillow blocks with re-lube bearings in low and high heights, four-hole flange units with re-lube bearings to 2-7/16 in., two-hole flange units with re-lube bearings to 2-3/16 in., tapered roller bearing flange blocks through 2-15/16 in. and take-up units in malleable housings, both re-lube and non-relube.
Browning Manufacturing Company, Maysville, Ky.

Standby Electric Plants. Beginning with the need for standby power, 8-page Bulletin 32c/ON outlines the steps to be considered in selection of an emergency electric generating plant. Suggestions are offered in planning and design of the installation—degree of protection desired, important things to consider, common errors to avoid. Items to meet particular requirements in specific installations are listed, including manual, automatic or instantaneous starting; type of fuel; air or water cooling; special heaters; radio shielding; plant exercisers and instrument panels. Advantages of both gasoline and diesel-powered emergency generator sets are presented and typical examples of both types of installation are shown. Representative models of each are listed, with basic specification data given.
D. W. Onan & Sons, Inc., 2515 University Ave., S.E., Minneapolis 14, Minn.

Solving Carryover Problems. Presenting a case history of a carryover problem, this flyer discusses the necessity of keeping internal baffling in good condition for the production of pure steam.
Betz Laboratories, Inc., Gillingham & Worth Sts., Philadelphia 24, Pa.

Plastics Ventilation Products. Rigivin (rigid vinyl) and Rigidon (reinforced plastics) collecting hoods, ducts, stacks, elbows and other fittings are the subjects of 20-page Bulletin B-500. Listing of standard sizes, specifications and chemical resistance data is included.
Heil Process Equipment Corporation, 12901 Elmwood Ave., Cleveland 11, Ohio.

Transmitter-Receiver Controls. Announced in four-page Bulletin 371 and Flyers 371-1 and 371-2 is introduction of this new line of transmitter and receiver equipment for remote temperature control. Applications of the system include heating, cooling, air conditioning and industrial processes. The Series 200 Transmitter transduces



One-story construction?

Floor space valuable?

Don't want long runs of ductwork?

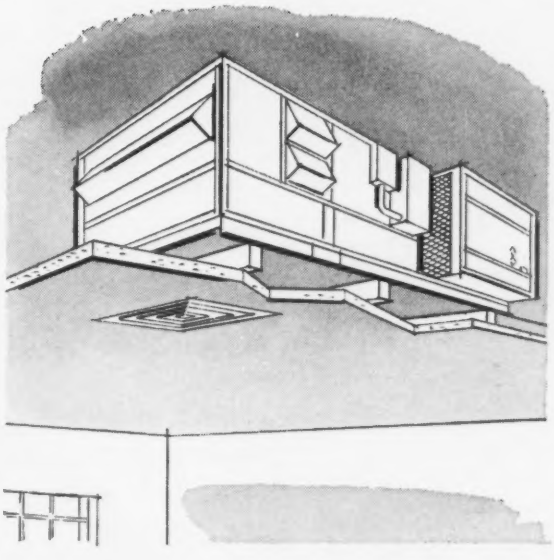
9 times out of 10 this is the most economical way to heat and cool a one-story building!

With the new Carrier Commercial Weathermaker*, year-round air conditioning can be designed and installed more economically than ever in one-story commercial or industrial buildings. It isn't necessary to give up an inch of valuable floor space, because this Weathermaker unit installs on the roof. And it isn't necessary to install expensive and unsightly ductwork, because the unit connects directly to a ceiling air grille. Notice the application here.

This unit is also designed to install with a minimum of time and trouble. It needs no water, no refrigeration piping, no charging with a refrigerant. One or more units can be installed as required, and with the following capacities: 7.5 tons of cooling and 200,000 Btus of heat . . . or 10 tons and 250,000 Btus. What's more, the motor-compressor is protected by a 5-year warranty.

For complete details about this Carrier Commercial Weathermaker, call the Carrier dealer near you. He's listed in the Yellow Pages. Or write Carrier Corporation, Syracuse 1, New York.

*Reg. U. S. Pat. Off.



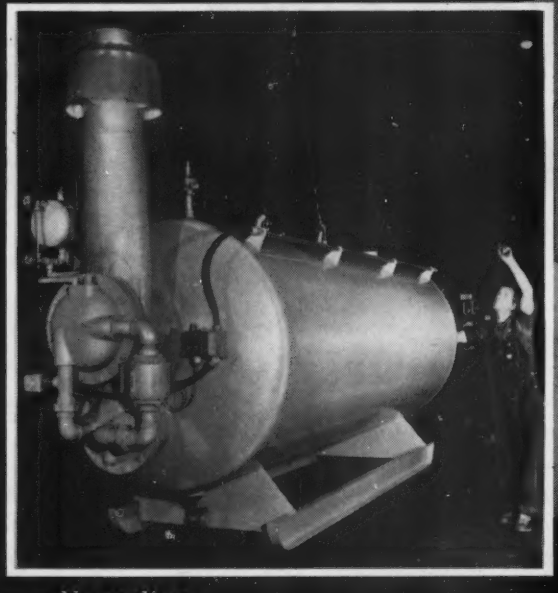
This Carrier 48B Commercial Weathermaker puts both the heating and cooling plant in the most economical of locations—the roof! It is supplied ready for fast one-unit installation. It is factory charged with refrigerant, equipped with refrigeration piping and quickly connected through the roof to a ceiling air grille.

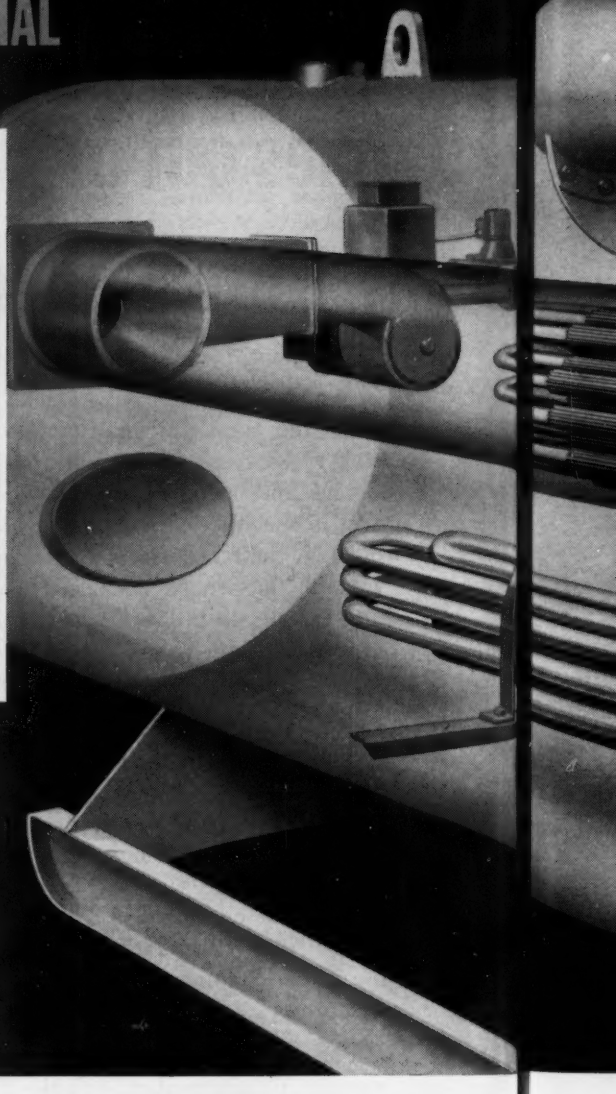
BETTER AIR CONDITIONING FOR EVERYBODY EVERYWHERE

Carrier

FIRST

INDIRECT GAS FIRED STORAGE WATER HEATER FOR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL USE





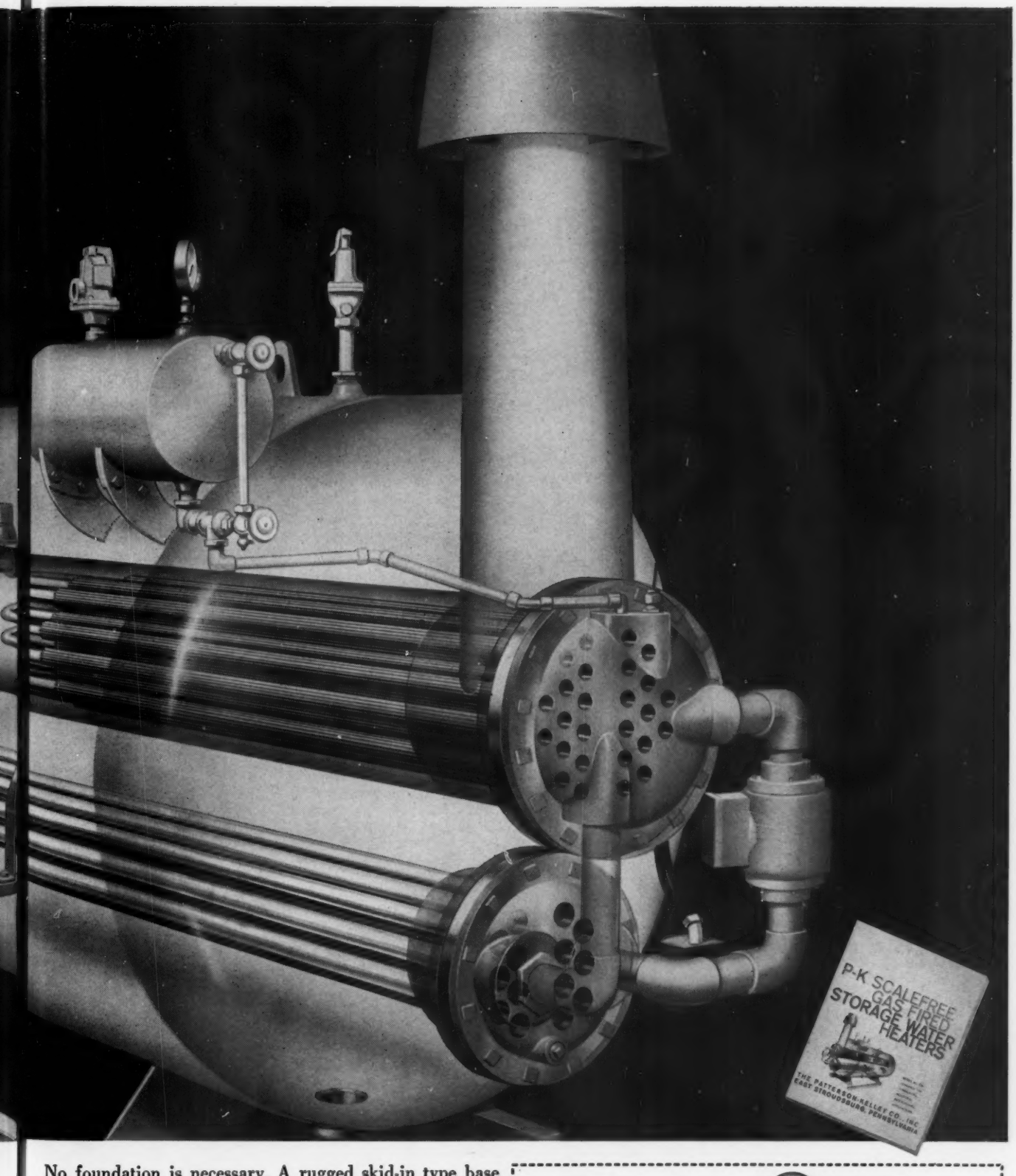
- *No scaling*
- *No drop-off in rated efficiency*
- *No fuel waste*
- *No on-the-job assembly*
- *No complicated maintenance*
- *No limitations on placement*
- *Fully automatic*
- *Copper heating surface*
- *Available in more than 100 storage and recovery combinations*

The first indirect gas fired design in storage water heaters is a rugged industrial type unit with finest controls and safeguards. It is backed by P-K's 80 years of experience in building and designing quality water heating equipment. Its name: SCALEFREE 230*.

P-K SCALEFREE 230 heats surface water through hot intermediate distilled water. Transfer occurs below the temperature at which minerals that cause scaling precipitate. Efficiency remains unimpaired throughout service life. Linings of Pre-Krete or copper are available to keep the unit free of rust and corrosion regardless of water conditions.

SCALEFREE 230 features a new P-K gas burner. It operates at maximum practical efficiency. Yet it gives almost noiseless service—does not rumble or boom on startup. This permits location almost anywhere in office buildings, institutions, schools, motels, etc.

SCALEFREE 230 is a complete fully automatic package that can be quickly set in place, hooked up, and checked out. It requires only simple electrical, water and gas connections. No stack is needed for extra draft—only a vent.



No foundation is necessary. A rugged skid-in type base is supplied. It is easily accessible for inspection. Tube bundles are removable.

SCALEFREE 230 is completely safe. It has a fail-safe chain of built-in protective devices. It is available in more than 100 storage and recovery combinations. Storage capacities range from 250 to 4000 gallons. Recovery sections range from 390,000 to 2,215,000 Btu. Send the coupon for complete information.

*Patent pending

Patterson Kelley

100 Morgan Ave., East Stroudsburg, Pa.

☐ Please send complete technical data on SCALEFREE 230

☐ Please have a P-K Sales Engineer call to discuss design and operational features.

Name_____ Position_____

Company_____

Address_____

City_____ Zone_____ State_____

a temperature measurement into a three to 15 psi air pressure signal from a remote location, which may be sent to a receiver gauge. Operating in conjunction with the transmitter, the Series 200 Receiver-Controller maintains a selected temperature at a remote location, comparing the transmitter air signal with its set point and adjusting its pressure to maintain the desired control.
Powers Regulator Company, 3434 Oakton St., Skokie, Ill.

Ceramic Fiber. Treated in an eight-page bulletin that gives properties, available forms and current uses of this high temperature material is Fiberfrax ceramic fiber. Typical uses discussed include linings for domestic oil burners and induction furnaces, general furnace insulation and critical applications in missile and space vehicle programs.
Carborundum Company, Buffalo Ave., Niagara Falls, N. Y.

Steel Piping in Ice Rinks. In a survey conducted in the United States and Canada, questionnaires were mailed to artificial ice rinks, with replies received from 193 in the U. S. and 126 in Canada. Of these, more than half use steel pipe. Details concerning these steel pipe rinks are contained in the fourth edition of this 16-page bulletin, "Steel Piping in Ice Rinks".
National Supply Company, Two Gateway Ctr., Pittsburgh 22, Pa.

Packaged Boiler-Burner Units. For oil, gas or combination firing, these forced draft square-heat units are the subject of a four-page Bulletin, Form No. 1145. Contained are ratings, dimensions and technical data in tabular form, typical specifications and a list of standard accessories.
American Radiator and Standard Sanitary Corporation, Industrial Div, Detroit 32, Mich.

Product Coolers. Units in this series of floor-type product coolers are hot dip galvanized after fabrication and assembly is done on exterior flanges. Listed in Bulletin F-1-60 are sizes, motors required, surge drums recommended and typical specifications. Units are available in sizes up to 30,000 cfm, with coils for ammonia, brine and other refrigerants up to 25,000 Btu basic rating.
Rigidbilt, Inc., 9240 W. Belmont Ave., Franklin Park, Ill.

Venturi Burners. Burners illustrated and described on this catalog sheet are of inshot and upshot type, all-steel construction, stamped and welded for light weight and flexibility for adaption to furnaces, boilers and hot water heaters. Btu inputs range from 5000 to 400,000, depending on the specific application. Four models, plus six basic venturis, are featured, together with design, application and construction information.
Barber Manufacturing Company, 1952 E. 134th St., Cleveland 10, Ohio.

Trailer Refrigeration and Heating Systems. 700 Series systems, described in 16-page Bulletin 5M/11/59, include a basic installation for regular sub-zero frozen foods and fresh foods service, as well as specifically modified systems for desert service, extreme low temperatures and premium fresh vegetable and meat service, and a "universal" model designed to give peak performance at extremes of the temperature scale. Rated performances, general installation arrangements, schematic wiring interconnection diagram, schematic piping diagram, roughing-in dimensions, simplified operating control diagram and specifications for the units are included.
Sumner Industries, Inc., Tru Kooler Div, Oelwein, Iowa.

1910 . . . Original Ric-wil one room building

1938 . . . Two story plant located on Brown Street in Barberton, Ohio

1960 . . . Present plant site in Barberton covers 10½ acres with 11 buildings.

1956 . . . Establishment of Ric-wil Company of Canada, Ltd. St. Thomas, Ontario

1959 . . . Establishment of Western Ric-wil Company, Newark, California

RIC-WIL...

50 Years of Growth

Fifty years of continued growth and expansion is a tribute to the RIC-WIL helically corrugated prefabricated insulated piping systems.* Systems that are engineered in correct basic design and quality built. Each unit, accessory and fitting is entirely prefabricated in factories equipped for this exclusive work. All conduit is pre-tested before delivery to the job site . . . in short . . . a system that offers the greatest strength and thermal efficiency obtainable for distribution piping.

Complete literature is available on the many types of systems . . . it's yours for the asking.

Covered by U. S. Patents: 2330966, RE. 22988, 2378214. Other patents pending.

Quality Piping Systems . . .
. . . of Exceptionally High Thermal Efficiency

RIC-WIL PREFABRICATED INSULATED PIPING SYSTEMS

CENTRAL OFFICE: RIC-WIL INCORPORATED, BARBERTON, OHIO
WESTERN STATES: WESTERN RIC-WIL COMPANY, NEWARK, CALIF.
IN CANADA: THE RIC-WIL COMPANY OF CANADA LIMITED

Ideal for Meat-Cutting Rooms

Modern supermarkets with self-service meat departments require properly refrigerated meat cutting and packaging rooms. Since space is always at a premium, Larkin Half-Turret Humi-Temps win applause for their ability to save space without sacrificing efficiency.

Here again, Larkin has chalked up amazing results in maintaining properly balanced temperature and humidity.

FEATURES THAT SELL

- Original, patented Larkin Cross-Fin Coil with staggered electro-tinned copper tubing and aluminum fins.
- Light-weight, rust-proof aluminum case finished in Larkin blue or gleaming white.
- Built-in heat exchanger.
- Permanently lubricated motors, resilient mounted, with thermal overload protection.
- Hinged drain pan for easy access to coil.
- Airplane-type, vibration-proof fastenings.
- Mounting brackets, slotted for easy installation.
- Fully insulated drain pan.

See your wholesaler or write for Bulletin 1049B.

WATCHDOG OF THE NATION'S FOOD AND COMMERCE ☆ LARKIN ☆

LARKIN COILS INC.

519 Memorial Drive, S.E. • P. O. Box 1699 • MUrray 8-3171
ATLANTA 1, GEORGIA

ALCO'S *New* P.O.S.

CHILLER CONTROL

THERMO® EXPANSION VALVE

Alco's New P. O. S. Valve is engineered with the Solenoid Pilot Stop Valve as an integral part of the P. O. Valve.

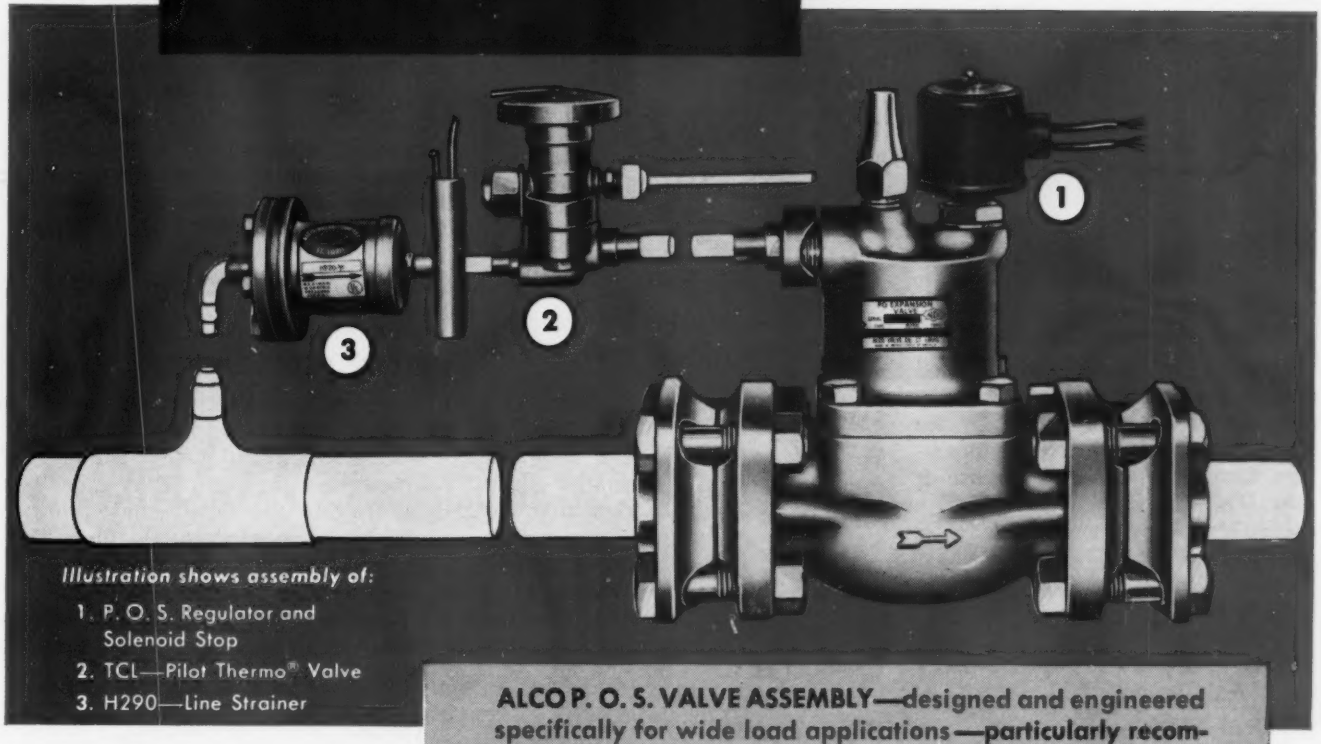


Illustration shows assembly of:

1. P. O. S. Regulator and Solenoid Stop
2. TCL—Pilot Thermo® Valve
3. H290—Line Strainer

ALCO P. O. S. VALVE ASSEMBLY—designed and engineered specifically for wide load applications—particularly recommended for refrigeration systems having capacity reduction—the ALCO SOLENOID PILOT STOP VALVE insures positive liquid "Shut-off."

ALCO PILOT OPERATED THERMO EXPANSION VALVES—give a positive control to 15% of nominal capacity with minimum superheat.

ALCO LIQUID LINE STRAINERS—insure positive protection of working parts from solder and dirt.

Capacities: 20 to 200 tons
Refrigerants 12 and 22

For Specifications—
Call your Alco Wholesaler, or write

ALCO

- *BUY SECURITY*
- *BUY QUALITY*
- *BUY ALCO*

ALCO VALVE CO.

855 KINGSLAND AVE. • ST. LOUIS 5, MO.

8220

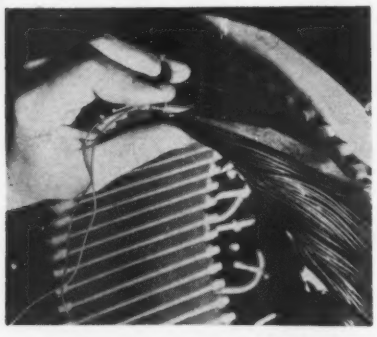
The one complete line of refrigerant controls: Thermostatic Expansion Valves • Refrigerant Distributors Solenoid Valves • Suction Line Regulators • Flooded Evaporator Controls and Reversing Valves

PARTS and PRODUCTS

OVERLOAD PROTECTED

Hermetic three-phase induction motors of 30 to 250 hp in the Tri-Clad '55 line are offered with a new type of overload protection, the Thermotector system.

Protection is provided by two or more miniature heat-sensing switches buried in the stator windings. These switches, connected in series with conventional motor control, shut the motor off whenever internal winding

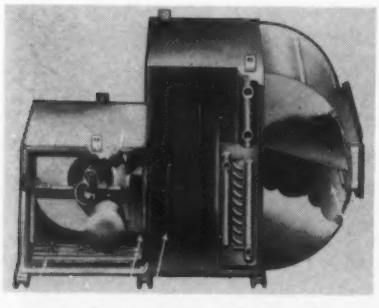


temperature exceeds a predetermined amount, regardless of rate of temperature rise. Under rapid rise the circuit is opened at a lower temperature than when the rate of rise is slow. Only two additional wires are used; there are no amplifying relays or complex circuitry.

General Electric Company, Schenectady 5, N. Y.

HIGH-VELOCITY EQUIPMENT

Now offered in a range of nine models (3500 to 27,000 cfm) for DX, cold water, hot water and steam, this high-velocity air conditioning equipment is for multi-storied applications. Engineered for hot and cold duct operation, at static pressures from two and one-half to eight in., the line has been redesigned to incorporate new factors, such as addition of a plenum divider



for ease of connecting ductwork on a double-duct system.

Option of horizontal or vertical discharge is offered, with other features including spring-mounted fan and motor assembly for internal vibration isolation, discharge plenum and baffle dividing hot and cold sections and one-half-in. vinyl-coated glass fiber insulation.

Drayer-Hanson Div, National-U.S. Radiator Corporation, 3301 Medford St., Los Angeles 63, Calif.

PIPE INSULATION

Unarco U-200, a light-weight, rigid, urethane foam pipe insulation, is specially designed for use at temperatures ranging from −300 to 220 F, and is cited as having a K factor of 0.14 at 70 F and a density of 2.3 lb/cu ft.

Non-toxic and non-irritating, the product can be cut to size and shape quickly and easily, and is available in half-round sections 36 in. long or in block form.

Union Asbestos & Rubber Company, 1111 W. Perry St., Bloomington, Ill.

SMOKE GENERATOR

For pinpointing leaks in heating, air conditioning and refrigeration ductwork, boilers, tanks, refrigeration cars and similar enclosures, the device shown, when ignited, generates easily visible smoke which issues through any openings that are present. The odor of escaping smoke gives a further warning of leaks.

After the test is completed, ventilation disperses the smoke, which leaves no residue. Non-toxic and non-corrosive, it contains no explosives, being generated by a chemical reaction process.

Superior Signal Company, Inc., 6 Colefax St., South River, N. J.

PRECISION SWITCH

Split-contact construction of the Unimax Type BK-1 enclosed snap-acting precision switch combines versatility in circuit control with high safety factor in heavy-current dc circuits. It can be wired as a single-pole double-throw switch with series contacts that break each circuit in two places at once, as a conventional SPDT switch with contacts paralleled to give decreased contact resistance or it can provide single-pole, single-throw, double-break action in two separate circuits operating alternately.

Sealed within a cast aluminum housing and actuated through a high-pressure spring plunger having a scraper that removes ice, dirt or other deposits that might interfere with switch operation, it is rated at 10 amp, 125 or 250 volt ac.

Unimax Switch Div, W. L. Maxson Corporation, Ives Rd., Wallingford, Conn.

GAS REFRIGERATORS

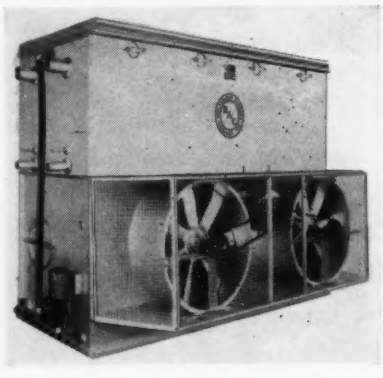
All three of the 13 cu ft models in this line are cited as eliminating problems of frost accumulation in both freezer and food compartments. All have thin-wall urethane foam insulation door gaskets designed for positive sealing.

In these 1960 models, the absorption system weight has been reduced 50% and the number of welds 30%. Consuming less gas than their predecessors, these units are so constructed that warm air is exhausted at the base of the refrigerator instead of the top rear.

Whirlpool Corporation, St. Joseph, Mich.

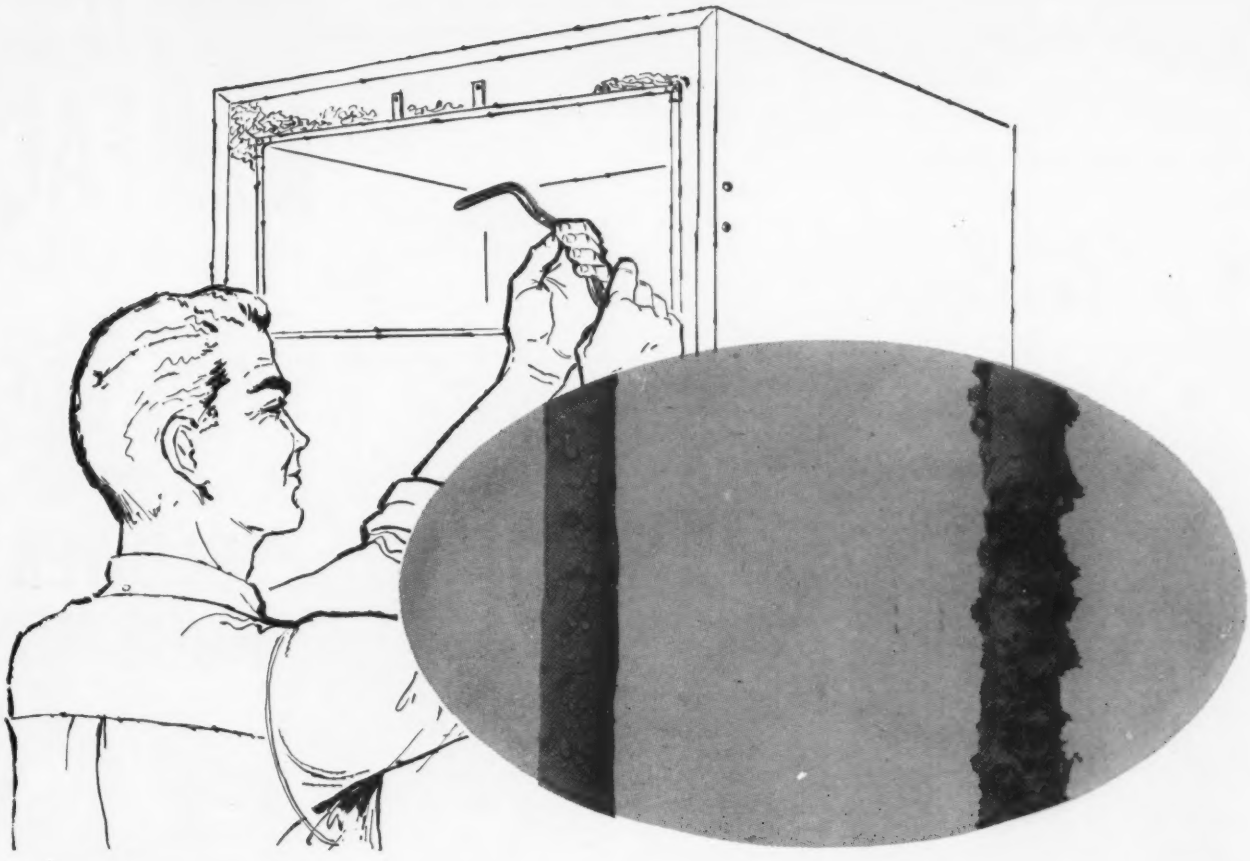
700-TON CONDENSERS

Evaporative condensers in this new line are offered in sizes up to 700 ton in factory-assembled units. All are constructed entirely of heavy-gauge steel hot-dip galvanized and protected by a zinc-chromatized aluminum finish. Three models are offered to cover most applications: centrifugal fan blow-through units (Model CPA), suitable for either indoor or outdoor



installation; centrifugal fan draw-through (Model CUA), available from ten to 100 ton with single air inlets for attaching to ductwork; and tube-axial fan blow-through units (Model CPA, shown in 175-ton unit).

Standard evaporative condensers come complete with installed pumps, bleed lines, strainers, fan guards and belt guards. Special features include: man-sized access doors at both ends, lift-out strainers, inspection ports on



New *Wat-R-Bar* outlasts conventional sealers 200 to 1 ...50,000 freeze-thaw cycles and *still* going strong

Here is a new standard for freeze-thaw resistance. The inset above tells the ***Wat-R-Bar*** story: after being subjected to 50,000 freeze-thaw cycles it is still in perfect condition, while a competitive sealer has long since broken down after just 250 cycles.

Wat-R-Bar is odorless, non-contaminating, non-toxic; permanently plastic, non-drying with excellent adhesion and cohesion on all types of clean surfaces. It will not become brittle at —40°F, or shrink with age; will not affect rubber, plastics or lacquer surfaces. Comes in attractive ice-blue or white, available in bulk, extruded beads or tapes for easy application.

If you have an installation that requires effective, lasting resistance to high humidity between similar or dissimilar materials—***Wat-R-Bar*** is the answer.

***FREE SAMPLE** is yours on request. Put it to the toughest test in your plant. Write Dept. R-3*

PRESSTITE Sealing Compounds

PRESSTITE DIVISION
AMERICAN-MARIETTA COMPANY

K A P

3790 CHOUTEAU AVENUE • ST. LOUIS 10, MISSOURI

both sides, removable spray tree branches and full-length access doors on draw-through units.
Baltimore Aircoil Company, Inc., P. O. Box 7322, Baltimore 27, Md.

PACKAGE ALTERNATOR

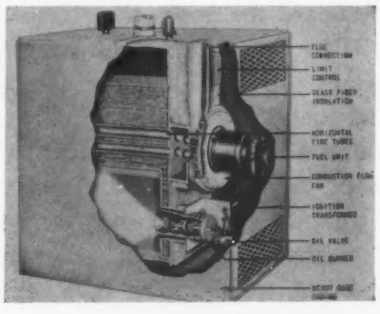
For use when an alternator is needed to actuate two pumps, this fully-wired package alternator connects to a 115 or 230-volt power supply. Equipped with diaphragm-type liquid level controls, it eliminates need for adjustment of float controls which, combined with use of submersible pumps, reduces maintenance.
Kenco Pump Div, American Crucible Products Company, 1307 Oberlin Ave., Lorain, Ohio.

REFRIGERATOR-FREEZER

Rated at nine cu ft for the refrigerator section and eight cu ft for the freezer compartment, Model FZ-195 uses freezing coils in the top, bottom, back wall and both sides of the freezer. Cited advantages include: no frost build-up, air temperatures remain at zero or below and quick cold recovery after door is opened and closed.
Manitowoc Appliances, Manitowoc 6, Wisc.

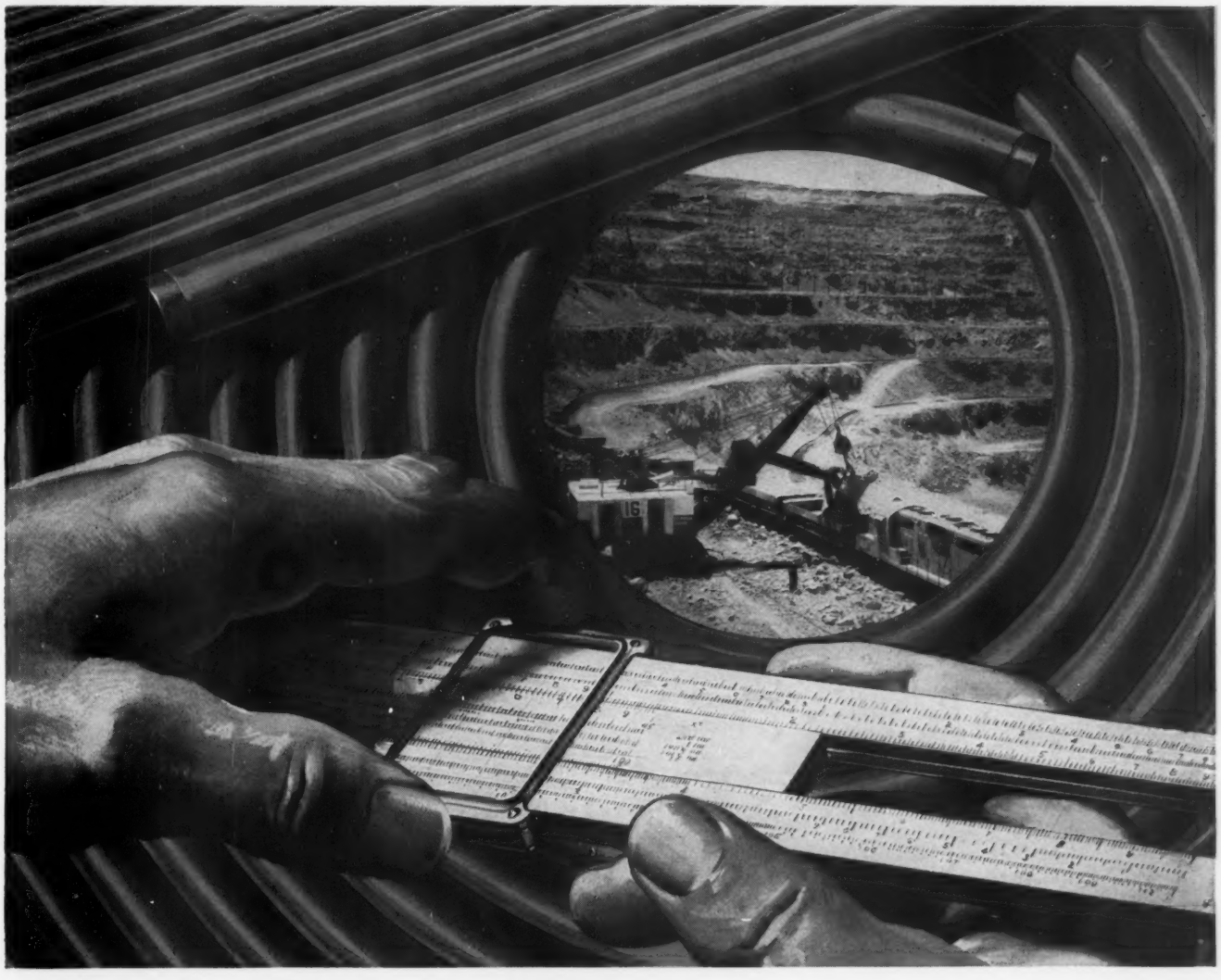
OIL-FIRED BOILER

Features cited for the Custom Mark II oil-fired boiler shown include: a "VoluMetric" firing system which leaves no unburned residue in the form of smoke, soot or carbon; combustion flow fan which controls the



amount of air introduced into the combustion chamber and eliminates dependence on uncertain or unsteady chimney draft; elimination of need for a conventional chimney; and the only opening into the system is the air-fuel injector inlet. There is no draft regulator, fire door inspection port or other secondary air openings which could upset the air-fuel ratio or admit cold air.

Stack temperatures are low, ranging from 350 to 400 F. Minimized standby loss makes practical use of this boiler for domestic hot water, in summer or winter. Optional all-



HERE'S WHY SO MANY ENGINEERS SPECIFY

Phelps Dodge Copper Tube for refrigerating, air conditioning and heating units!

1 Phelps Dodge has complete control of its copper tube from original source to finished product. The copper used in Phelps Dodge tube comes from Phelps Dodge-owned open-pit mines, is smelted in Phelps Dodge refineries and fabricated in modern Phelps Dodge mills. This overall Mine-to-Market control is assurance of highest quality and finest workmanship.

2 Phelps Dodge devotes particular attention, throughout fabrication, to uniform anneal for tube flaring and careful control of die draw for close tolerance.

3 Phelps Dodge can supply maximum tube lengths and precise wall thicknesses engineered to customer specifications; straight length tube tempered to meet bending and expanding requirements.

4 Phelps Dodge multiple mill operation guarantees a steady source of tube supply to meet the needs of manufacturers of refrigerating, air conditioning and heating equipment.

It's the famous Mine-to-Market Quality Line . . . sold the quality way—through authorized wholesalers!

PHELPS DODGE COPPER PRODUCTS CORPORATION

New York, N.Y. • Los Angeles, Calif.

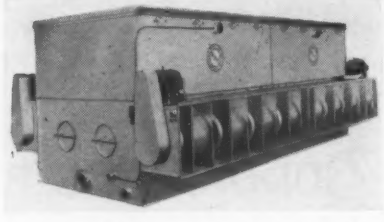
copper water heating coils are built into the boiler, and two-temperature hot water can be made available if desired.

Two sizes, rated at 110,000 and 145,000 gross Btu/hr, are available. Boilers are of the steel tubular type, wholly enclosed in enameled steel cabinets and are small and compact. **Iron Fireman Manufacturing Company, 3170 W. 106th St., Cleveland 11, Ohio.**

700-TON COOLING TOWER

Offering for the first time factory-assembled units up to this size as a standard line, this manufacturer has produced three models: centrifugal fan blow-through units (Model THA, shown); centrifugal fan draw-through (Model TUA), with single air inlets for attaching to ductwork; and tube-axial fan blow-through (Model TPA). Suitable for either indoor or outdoor installation, blow-through models up to 100 ton are also the first dry fan units offered by this company with connection flanges for ductwork on the air inlets as well as outlets.

Special features in the new line are large access doors located in both ends of all units, lift-out strainers of anti-cavitating design that can be cleaned and replaced without any mechanical effort, inspection ports on both sides, spray tree branches that

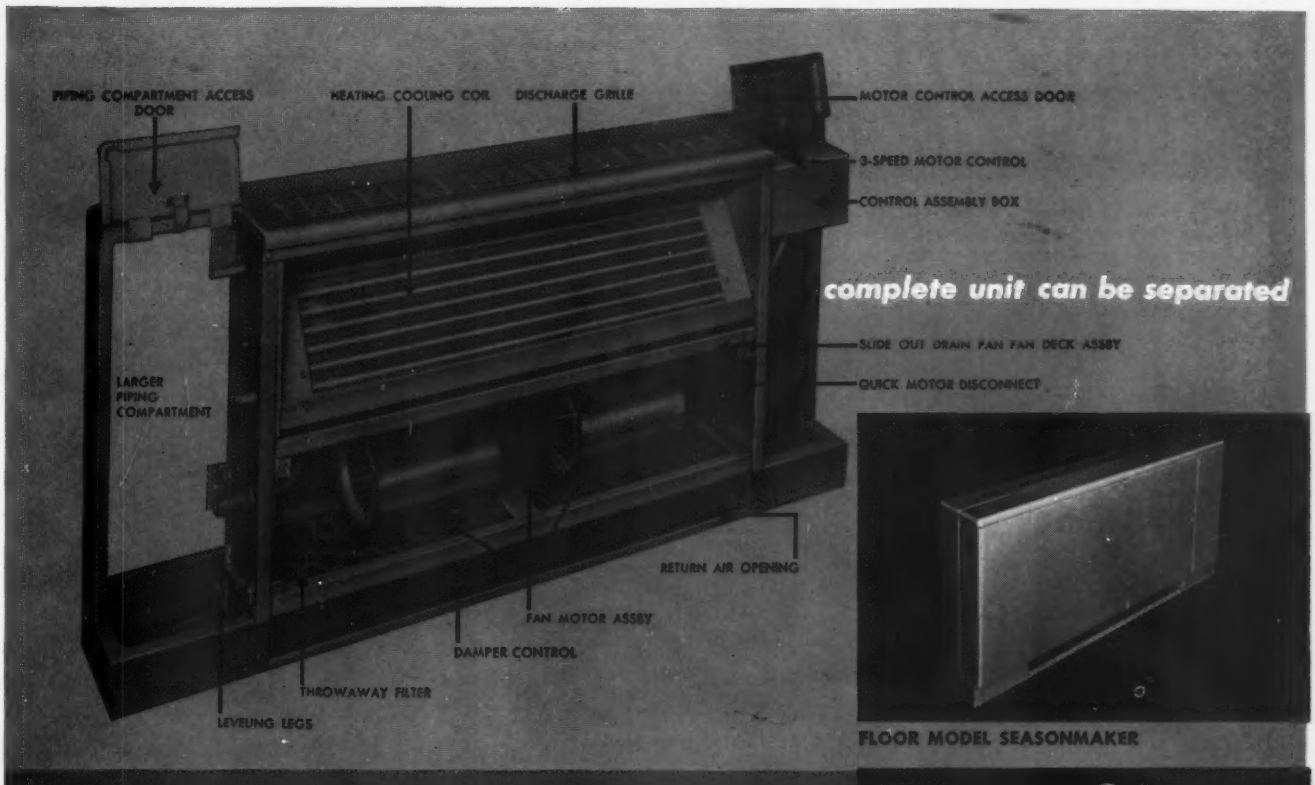


are removable for cleaning as well as the usual threaded spray nozzles, orifices and flush-through spray headers, and full-length access doors on draw-through units for removing eliminators and inspecting fans and bearings. **Baltimore Aircoil Company, Inc., P. O. Box 7322, Baltimore 27, Md.**

PRESSURE-SENSITIVE TAPE

Applicable at temperatures as low as −5 F, this polyvinyl chloride pipe protection tape is designed for conformability over a broad temperature range, with optimum properties for pipe corrosion protection. Designated "Scotchrap No. 40," it requires no heat or tools to apply and is cited as giving positive protection of joints, tees, couplings and other shapes.

High insulation resistance and electric strength of the tape remain stable in the presence of water and guard against damage from such occurrences



So Versatile, So Dependable ...and So Easy to Work With

McQuay thin-line design SEASONMAKER

McQuay thin-line design individual room Seasonmakers are popular, not only because of their convenient size, their high efficiency and their inherent quality, but because they are so extremely versatile and dependable. Every part is easily and quickly accessible. They are easy to install and easy to work with. For example, filters are easily changeable; the slide-out fan deck is quickly removable; the hand of coil is easily reversible in the field.

All McQuay Seasonmakers utilize central station heating and cooling and are available with capacities of 220, 330, 440, 520 and 640 cfm. They furnish individual room comfort at any desired temperature level—heated, filtered air in winter and cooled, dehumidified and filtered air in summer. Seasonmakers are ideal for multi-room buildings such as hotels, apartments, motels, schools, hospitals, offices and residences.

If you haven't already done so, investigate McQuay individual room Seasonmakers. For complete information call the McQuay representative in or near your city, or write McQuay, Inc., 1606 Broadway St. N. E., Minneapolis 13, Minnesota.

ONLY 8 1/2" THIN
25 INCHES HIGH

4 Models In 5 Sizes

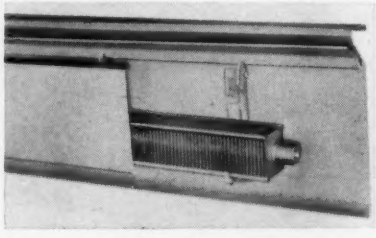
McQuay INC.

AIR CONDITIONING • HEATING • REFRIGERATION

as lightning strikes and grounded high voltage cables. With a high-tack adhesive system, it stops tape displacement caused by movement of soil or pipe, and it is resistant to acids, alkalies, salts, petroleum oils and refined petroleum products.
Minnesota Mining and Manufacturing Company, 900 Bush Ave., St. Paul 6, Minn.

HYDRONIC BASEBOARD

Available in lengths from two through 20 ft in one-ft increments, Panel-Track, the ¾-in. hydronic baseboard shown here in a cut-away view, is supplied with a mechanical damper and one-piece pendulum-action hang-



ers. Four expansion tracks interlocked to the corners of each fin provide "free-flow" expansion, with no clips or slide cradle devices required.
Embassy Steel Products, Inc., 890 Stanley Ave., Brooklyn 8, N. Y.

Ready to Roll on your Production line...

...COILED GM STEEL TUBING

Top refrigeration people depend on top tubing people

Coiling—available up to 2000 feet—eliminates unnecessary joints and short end waste—adapts most economically to modern production line techniques and provides better inventory control at less expense. Add GM Steel Tubing standards for quality, strength and cleanliness and schedule-meeting delivery service. You'll have the unbeatable combination that top refrigeration people know they can rely on. For detailed data write or wire GM Steel Tubing Sales Manager, *Rochester Products Division of General Motors, Rochester, New York.*

Precision Level Winding equipment produces level wound steel tubing coils. Accurate control lays each wind level with adjacent tube and insures precise coil dimension. This procedure insures easy adaptation to production line requirements at modest extra cost. Details on request.

GM

STEEL TUBING
BY ROCHESTER PRODUCTS

AMERICA'S LARGEST MANUFACTURER OF REFRIGERATION TUBING

CLASSIFIED ADVERTISING

RATES—Classified advertisements at this heading are inserted in 8-point type at the rate of $1.00 per line or fraction thereof, including heading and address. Eight words to the line average. Box number address counts as one line. Minimum insertion charge, 5-line basis. Maximum insertion 10 lines. Prices are net, no discounts. Box number replies promptly forwarded without charge. Available Engineers insertions up to 60 words for Full and Associate members, and Affiliates are carried free.

NO DISPLAY advertising at this heading.

CLOSING DATE: Copy must reach publisher by 10th of month preceding date of issue.

NO PROOFS shown; no free checking copies. (Single copies 50c each with order.)

Address classified advertising or requests for further information to ASHRAE JOURNAL, 62 Worth St., New York 13, N. Y.

OPENINGS

DRAFTSMEN—with experience in compressor and components or refrigeration piping layouts. Send experience and education resume to Frick Company, Waynesboro, Pa.

PROJECT ENGINEER—New opening created by continuing expansion of leading manufacturer in its field of specialized temperature control equipment. Engineering degree and minimum 5 yr experience in systems design and equipment selection. Will work primarily on large projects with unusual and challenging problems. Starting salary to $10,500 plus liberal fringe benefits, profit sharing, and excellent chance for advancement. Send record of education, experience, and earnings to Vice Pres., P. O. Box 382, Richmond, Va.

REFRIGERATOR CABINET ENGINEER required for home freezer department. Must be familiar with production techniques in metal fabricating industry, tooling and materials used in refrigerators and freezers. 3 to 5 yr experience preferred. State qualifications and salary requirements. All replies held in confidence. Write, phone or wire information to Bryan E. Thompson, Personnel Director, Food Freezer Div., Carrier Corp., P. O. Box 2010, Tyler, Texas.

REFRIGERATION SALESMAN—Established refrigeration and air conditioning contractors in Pacific northwest have openings for experienced man and for junior engineer. Excellent opportunity now and future handling established lines with national recognition. Western Engineers, Inc., 2105 S.E. Nineth, Portland 14, Ore.

MANUFACTURER'S REPRESENTATIVES wanted. Soon the entire United States will be the market for "America's most efficient, completely engineered Oil Heat Package Unit—Dynatherm! If you are presently calling on heating wholesalers and jobbers, are sincere, ambitious and interested in representing us in an exclusive area, write immediately to: Raymond Dietz, Sales Mgr., Dynatherm Division, Bethlehem Foundry & Machine Co., 225 W. Second St., Bethlehem, Penna.

MECHANICAL ENGINEER—Excellent opportunity for Project Manager, Project Engineers, and Design Section Chiefs experienced in design of heating, ventilating, air conditioning, piping, power plants. Wide Variety of work (including client contact) with established Midwest consulting firm. Permanent. Good starting salary, advancement, and vacation program. Moving expenses paid. All replies answered. Box 923, ASHRAE JOURNAL.

MANUFACTURERS' REPRESENTATIVES wanted for nationally accepted line of commercial roof-mounted heating and cooling units for Arkansas, North Carolina, Virginia, West Virginia, Greater Pittsburgh, New Mexico, Arizona, Utah, Nevada, West Texas. Write Box 942, ASHRAE JOURNAL.

HVAC ENGINEERS—Project Engineers and Asst. Project Engineers required by large, progressive contractor in Greater New York area. Commercial-industrial contracting experience and/or design experience desirable. Permanent positions, company benefits. Send resume and previous earnings. Box 948, ASHRAE JOURNAL.

ENGINEERS, CHECKER-COORDINATOR—Experience in coordinating shop drawings and work of mechanical building trades. Thoroughly familiar with detail checking. Company benefits. Permanent positions with large, progressive contractor in Greater New York area. Send resume and previous earnings. Box 949, ASHRAE JOURNAL.

DESIGN AND DEVELOPMENT ENGINEERS wanted with ME degree. Must be 4 to 5 yr out of college, with experience in air handler phase of air conditioning industry, or centrifugal refrigeration units and/or absorption systems. Excellent opportunity for young men in one of industry's growth companies. Midwest location. Send resume to Box 952, ASHRAE JOURNAL.

ASSISTANT SALES MANAGER to work with Vice President of Sales in supervising and developing national sales organization. Prefer graduate engineer in early thirties with experience in air conditioning and refrigeration sales. Unusual opportunity with leading eastern manufacturer. Box 958, ASHRAE JOURNAL.

REPRESENTATIVE wanted. Opportunity to provide highly desirable, non-competitive service exists for manufacturer's representative now calling on refrigeration and cold storage industry. An exclusive territory with little time and no investment will handsomely reward our special representative. Your reply stating lines now carried, territory and reference will be given every consideration. Box 960, ASHRAE JOURNAL.

AVAILABLE

AIR CONDITIONING AND HEAT PUMP ENGINEER—22 yr experience. Window type and residential air conditioning package systems, heat pumps, systems design, unit coolers, heaters, finned coils. Thoroughly familiar with design, testing, production methods, tooling, purchase specifications. N.Y.P.E. license. Prefer Western New York State location. Box 869, ASHRAE JOURNAL.

MECHANICAL ENGINEER—P.E., member ASHRAE, 26, single, Canadian, residing in Canada. Require greater scope in heating, air conditioning, or refrigeration system design or sales with consultant manufacturer or contractor. Experience: completed Westinghouse graduate training and sales course; sold air conditioning and heating equipment. Presented doing heating design for schools. Will locate anywhere. Resume on request. Box 950, ASHRAE JOURNAL.

HEATING, AIR CONDITIONING ENGINEER—Sales Manager. Full member ASHRAE, age 45. 20 yr heavy manufacturing and field experience in dealer, distributor, retail, builder, government, commercial sales, application, installation, design. Heat pump authority. Employed but stymied. Seeking regional management position Mississippi westward. Headquarters East Texas metropolis. Requires good salary, incentive, car, expenses, operational freedom. Box 951, ASHRAE JOURNAL.

ENGINEER EXECUTIVE—experienced in refrigeration, air conditioning and related fields of mechanical and electrical engineering and in cabinet production, desires position or association with progressive manufacturer with substantial product line or planning expanded line. 30 yr experience directly applicable to improvement of your operation and products. Box 953, ASHRAE JOURNAL.

AIR CONDITIONING AND REFRIGERATION ENGINEER with 10 yr experience in all phases of large commercial and industrial specialized systems seeks challenging managerial position with progressively thinking and acting organization. Box 954, ASHRAE JOURNAL.

ENGINEER thorough experience in large size refrigeration and air conditioning systems. Design, estimating, proposals, sales engineering, field engineering, trouble shooting, etc. Also experience supervising installation, service and maintenance work. Familiar with wide range of associated equipment. Worked with well known equipment manufacturer and mechanical contractors. Resume on request. Desire position metropolitan New York area. Box 955, ASHRAE JOURNAL.

MARKETING-ENGINEER EXECUTIVE—age 36. Presently Asst. to top executive officer Sixty Million Dollar company. 15 yr experience sales, marketing, engineering, product planning, administration in air conditioning and refrigeration. Desires challenging association with reputable manufacturer, distributor or contractor. N. Y., Conn., N. J. area preferred. M.S., General Business, BSME. Box 956, ASHRAE JOURNAL.

FORMER CHIEF ENGINEER of medium size air conditioning equipment manufacturer now Professor of Mechanical Engineering at University desires summer employment outside U. S. Registered P.E., thoroughly familiar with all phases of equipment design, manufacture and service. Box 957, ASHRAE JOURNAL.

AIR CONDITIONING & REFRIGERATION ENGINEER—desires position with consulting firm or manufacturer. Experience in testing and design of condensing units, hermetic compressors and window units. Will relocate. Box 961, ASHRAE JOURNAL.

Applications

WALL PANELS TO HEAT DORMITORY OF ILLINOIS HOSPITAL

Added to the Methodist Hospital of Peoria, Ill., a four-story nurses' dormitory will be heated electrically by wall panels, manufactured by Sun-Tron Corporation, in individual rooms and service areas and a heat pump for the first floor reception and lounge area of the installation.

Granite slabs 8½-ft square and four in. thick with aluminum windows set between them will form the walls of the building. Under the windows and within the window recess will be the 31 x 30-in. heating panels. Wattages will vary from 1000 to 1500 to accommodate difference in room size and greater heat loss on the top floor. Each of these panels will be equipped so that a key switch under the room thermostat can be used to disconnect a portion of the heating elements in spring and fall to save on operating costs and to reduce overall demand charges.

HEAT PUMP SERVICES RINKS FOR WINTER OLYMPICS

In addition to servicing ice areas consisting of two standard hockey-size practice rinks and a 440 meter oval speed skating rink, the heat pump supplied by York Div, Borg-Warner Corporation, to Squaw Valley, Calif., will also keep snow from piling up on the roof of the 8000 seat arena and provide both spectator heating and domestic hot water.

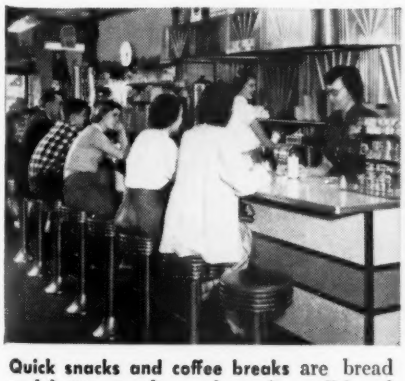
Estimating the load at 550 ton when cooling 5500 gpm of calcium chloride brine to 14 F, engineers selected a single centrifugal brine cooling system with main brine pump, three-way valves and recirculating pumps at each rink to meet this requirement. Use of the cooling system condenser heat rejection to assist in heating the arena enables it to be kept at approximately 50 F at peak heating load conditions and higher when the load is not at peak and snow thawing is not required.

Housed in the refrigeration equipment room are the main brine pumps, brine chiller, booster compressor, auxiliary heating devices and electrical control equipment. Below the floor of the room the main brine storage tank is located, and in a walled-off portion of this tank, space is provided for the main refrigerant operating receiver. Vertical turbine brine pumps extend from the machine room floor into the brine tank and pump directly into the brine chiller and then to the rink areas. Over one end of the equipment room is located the first of two fan rooms in which the heating coils are located; the other fan room is located 60 ft beyond the opposite end of the equipment room. Outside air evaporators are approximately 300 ft external to the equipment room.

ADVERTISERS INDEX

In convention halls, coffee shops and commuter trains...

Heated discussion is still a convention trademark, but physical swelter has given way to air-conditioned comfort in giant convention halls. The amount of air-conditioned space needed for meetings and exhibits often has a bearing on the location chosen for major conventions.



Quick snacks and coffee breaks are bread and butter to the modern air-conditioned "coffee shop"—a relatively new and thriving institution in busy urban centers.

Brow-mopping days are over for many train travellers, thanks to air-conditioning. Air-conditioned cars pay off in increased traffic—and immeasurable good will.

You'll find

genetron®

SUPER-DRY REFRIGERANTS

Approved!
Accepted!
Preferred!

For great and small cooling jobs by the thousands—for original or replacement charge—you'll find "Genetron" Super-Dry Refrigerants approved . . . accepted . . . preferred! Men who manufacture America's finest refrigeration and air-conditioning equipment as well as those who design it, install it and service it, all endorse "Genetron" Super-Dry Refrigerants. Wholesalers recommend them for their consistent high purity, maximum dryness, and over-all top quality.

"Genetron" Super-Dry Refrigerants are stocked from coast to coast by all leading wholesalers. Use the best! Insist on "Genetron" Super-Dry Refrigerants!

genetron 11 ORANGE LABEL CCl_3F
TRICHLOROMONOFLUOROMETHANE

genetron 12 WHITE LABEL CCl_2F_2
DICHLORODIFLUOROMETHANE

genetron 22 GREEN LABEL $CHClF_2$
MONOCHLORODIFLUOROMETHANE

genetron 113 PURPLE LABEL $C_2Cl_3F_3$
TRICHLOROTRIFLUOROETHANE

genetron 114a BLUE LABEL $C_2Cl_2F_4$
DICHLOROTETRAFLUOROETHANE

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

Allied Chemical

"we do everything with GAS ...heating, cooling, cooking, even lighting."

Vance Thompson, President Coachman's Inn, Little Rock, Ark.

The new Coachman's Inn...a 258 unit downtown motel in Little Rock . . . is the last word in ultra-modern convenience and comfort. In the words of satisfied guests, it has everything.

And everything there that depends on fuel depends on GAS, the most flexible modern fuel. Even the electricity used at the Inn is produced by a gas-driven generator!

Year 'round air conditioning for the Inn starts at a gas-fired boiler. In summer this boiler furnishes the source of energy for a series of Arkla-Servel gas absorption cooling units. In winter the same gas-fired boiler heats the Inn.

Air-conditioning is only part of the job for gas at the Coachman's Inn. Gas cooks the meals. Heats all water, including the swimming pool. Illuminates the decorative Arkla Gaslites. And, in gas flambeaux, adds a dramatic touch to the beautiful Sunken Patio.

No wonder the owners say, "We do everything with GAS." If you plan to build or modernize any building, check the efficiency, flexibility and economy of gas. Gas absorption cooling can put your heating plant on a year 'round paying basis.

For specific details, call your local gas company, or write to the Arkla Air Conditioning Corporation, General Sales Office, 812 Main Street, Little Rock, Arkansas. AMERICAN GAS ASSOCIATION.

FOR HEATING, COOLING, COOKING ...GAS IS GOOD BUSINESS!